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THE CONSTRUCTION OF LAKE VESSELS FOR Atlantic trade has been seriously taken up by the Northwestern Steamship Co., of Chicago, Ill., which has built four sister ships, each 225 ft. long, intended to ply regularly between Chicago and European ports. These vessels—the "Northwestern," "Northward," "Northeastern" and "Northtown"—announce their sailing in May for Hamburg, Liverpool and London, taking from Chicago cargoes of machinery, canned and boxed meats, lard and other products of the Lake region. These ships, says the U. S. Treasury Bureau of Statistics, are of the lake type of construction; but are designed to combine lake and ocean traffic, and are equipped with special facilities for rapid loading and unloading. They will necessarily pass through the Welland and St. Lawrence canals, traversing 73 miles of canals and passing 46 locks in reaching Montreal. But they depend on their own propelling power throughout. The time to be consumed between Buffalo and Montreal is estimated at about three days. The depth of the Welland canal is 14 ft., while most of the Lake harbors have 20 ft. of water, and the advent of these vessels is used as an argument for a 20-ft. American canal from the Lakes to tidewater.

THE GEORGIAN BAY SHIP CANAL project was discussed at considerable length at a late meeting of the Montreal Board of Trade, by Mr. Ernest E. Sawyer, one of the Chief Engineers of the Manchester Ship Canal. In outlining the plan proposed, he insisted upon a 20-ft. waterway, as ships of 4,000 to 10,000 tons were now passing the Sault Ste. Marie Canals, and any less depth than 20 ft. would be out of date. The locks would be 500 ft. long by 60 ft. wide, with 23 ft. on the sills; and the route would require about fifty of these locks. The distance from Georgian Bay to Montreal is 430 miles, by the line surveyed; of this distance, the 120 miles from Montreal to Ottawa is now covered by a 14-ft. waterway; or 15 miles by canal and the remainer by open stretches in the Ottawa and St. Lawrence rivers. Above Ottawa are stretches of sheltered lake and river navigation, leaving only about 29 miles of canal to be actually constructed. For the most part these lakes have a channel depth of 20 to 30 ft., with few spots as shallow as 15 ft.; and the Deep River is straight for nearly 30 miles and has an average depth of 300 ft. The estimated cost of the whole system is $67,000,000, with five years required for construction. In speaking of the prospective trade and of freight tariffs, Mr. Sawyer said that the present lowest tariff from Chicago east to the seaboard, or from Kansas City south, was 9 cts. a bushel on grain; and as showing the economy of water transport over railways he noted that Lake Superior iron ore was carried about 1,000 miles for 1⅛ cts. per ton. He believed that grain could be carried from Chicago to Montreal, by the route proposed, at 3 cts. a bushel, as against 4½ cts. from Chicago to Buffalo. In comparing the lengths of routes from Chicago to Liverpool he claimed that all advantages were with the Georgian Bay route. A grain vessel leaving Chicago for New York has to make a journey of 920 miles to Buffalo, and 350 miles by canal and 145 miles on the Hudson River, to New York. The vessels for Montreal has to sail only 550 miles to the French River, and 430 miles to Montreal; with 20 instead of 350 miles of canal to traverse. And at Montreal this latter vessel is 450 miles nearer to the European market than the vessel at New York. In the through trip to Liverpool, Mr. Sawyer thus figures a total saving in distance of about 900 miles, in favor of the Georgian Bay route. He spoke of 50 cts. per ton toll as being low compared with the $1.60 per ton levied on the Suez Canal, for example. Mr. Sawyer urges the Canadian Government to guarantee the bonds for the undertaking, at an annual outlay of $2,800,000, if the canal should not pay; though he and his friends foresee a great commercial success. In connection with Mr. Sawyer's remarks the article on the dangers of St. Lawrence River navigation published elsewhere in this issue will prove interesting reading.

THE ST. LAWRENCE SHIP CANAL is being deepened to 30 ft. and widened to 450 ft., and there is talk of increasing the depth to 35 ft. and the width to 600 ft. About twelve years ago the canal was completed to a depth of 27 ft. at low water and to a minimum width of 300 ft. from Montreal to the sea. The new work is being done mostly by the government, which is now adding several large high-powered modern dredges to its fleet and remodeling the government shipyard at Sorel, Quebec, by the addition of steel buildings and new tools. This activity is mainly due to the progressive policy of Mr. Tarte, the Minister of Public Works, and the additions are being made under the engineering guidance of Mr. A. W. Robinson, M. Am. Soc. C. E. Two large steel-hulled dredges are now being built from Mr. Robinson's designs, one for British Columbia and the other for the St. Lawrence. Mr. Robinson has also been commissioned to examine the seaport channels in Nova Scotia and New Brunswick, with a view of designing a large self-propelling dredge to suit the conditions there existing.

THE TONNAGE AND VALUE OF FREIGHT PASSING through the Sault Ste. Marie Canal, from 1887 to 1900, inclusive, is given by the U. S. Bureau of Statistics. While the table is for each year, the five-year periods will suffice to show the rapid growth of this trade, as follows:

Year.	Total freight, net tons.	Value.
1887	5,494,649	$79,031,757
1890	9,041,213	102,214,948
1895	15,062,580	159,575,129
1899	25,255,810	281,364,750
1900	25,643,073	267,041,959

THE CHICAGO RIVER COMMISSION, whose work was described in our issue of May 2, has been somewhat summarily dismissed, without having a chance to present any report. The reason seems to be that as a bill has (with much difficulty) been put through the Illinois legislature authorizing the Trustees of the Sanitary District to raise an additional $5,000,000 by the issue of bonds, the Trustees are not in favor of any further participation of outside parties in their plans. The mass of information, detailed estimates, etc., compiled by the expert commission will be turned over to the Trustees.

THE OFFER TO SELL THE PANAMA CANAL to the United States, reported as made by President Hutin, of the new Panama Canal Co., does not amount to much, say Washington items of May 8. All the company has to sell is a very much involved interest in a concession which reverts to the Colombian government in 99 years, as sole owner. The old Panama Canal Co. still has interests in the canal which are not included in the offer made, but which would have to be considered. By mutual agreement and in consideration of the transfer of the old company's property, the new Panama Canal Co. has agreed to pay $20,000,000 for the Panama Railway, in case it did not complete the canal. If the canal is built the new company becomes the owner of the railway; but half the net profits from the operations of the canal are to be paid to the old company in perpetuity. Under this very much involved situation, no mere offer by the new Panama Canal Co. to sell a controlling stock interest, or to sell the improvements made, could be considered by this government.

NO VERY SERIOUS STEAM RAILWAY ACCIDENTS are recorded for the past week. Many persons, however, were injured in a trolley car accident at Leonia Hill, New Jersey, on May 12. The car, containing more than 100 passengers, became uncontrollable on a steep hill and attained a high speed. It left the track at a curve at the bottom of the hill and was completely wrecked, and 20 persons were more or less seriously injured.

THE MISSISSIPPI RIVER STEAMER "City of Paducah" sank after striking a snag at Brunkhorst Landing, near St. Louis, Mo., on May 12. The bodies of two passengers have been recovered, and 22 members of the crew are believed to have been lost.

AN OUT-OF-ORDER INDICATOR FOR BLOCK SIGnals, devised by Mr. Walter Gravit, Assistant Master Carpenter, Lake Shore & Michigan Southern Ry., Elkhart, Ind., was described in a short paper read before the Railway Signaling Club at its meeting of May 14 in Chicago. The device consists of a small fish-tail blade, with a glass to permit the use of a regular signal lamp to give a night indication, but so constructed as to leave the signal number exposed; which is placed, when occasion demands, in a permanent socket on the signal post. Each maintainer is supplied with one or more of these blades, according to the number of signals he is caring for, and can very easily take them along when going to a signal that has been reported defective. Should his territory be large, the blades can be kept in the section house nearest to the signal, and the section foreman be instructed to apply one as soon as the signal goes wrong, thus avoiding full service stops at a signal out of order between the time it first goes wrong and the time at which it is possible for the maintainer to get to it. The cost of these indicators complete is about $4.75 each.

FULL SIZE FIRE TESTS of a Lucknow window, the Hayes window and Standard fire shutters will be held on May 17, 1901, at 516-525 West 14th St., New York city, under the supervision of the Board of Buildings.

STREAM POLLUTION AT WASHINGTON, PA., has been forbidden in response to a suit brought against the borough by the Tyler Tube Pipe Co. and others. The court holds that the discharge of sewage into the stream has become a nuisance.

THE SITE FOR THE SLOW SAND FILTRATION plant at Washington, D. C., the selection of which was noted in our issue of May 9, is large enough to provide for a net filtration area of 33.2 acres, the total area being 45.3 acres. The estimated cost of a filter plant on this site is $2,402,043, of which $650,391 is for land and $219,300 for grading. A little preliminary work has been done. The appropriation thus far available is $700,000. The commission that chose the site was composed of Lieut. Col. A. M. Miller, Capt. Lansing H. Beach and Capt. D. D. Gaillard, with First Lieut. G. M. Hoffman as recorder. The estimated cost given above is for a net filter area of 26.92 acres.

THE BARREN ISLAND GARBAGE REDUCTION Works Bill, passed by the New York legislature of 1900 to suppress the plant, has been declared unconstitutional by the New York Court of Appeals. In affirming the decision of the lower court, the opinion concludes as follows:

> The act only authorizes subordinate local officials to prohibit the business in certain of the boroughs of the City of New York, while it destroys the business in one specified borough, and in substance deprives this plaintiff of the use of its vast property in that borough, takes from it the benefit of its contract rights, and subjects it to oppression of a statute which is operative only in a portion of the municipality. Such a law we cannot but regard as arbitrary and not framed in the interest of the general public of the Greater New York City. It would appear when construed with reference to existing conditions to have been aimed merely at the destruction of particular interests. It is not an act for the general regulation of a business which might be conducted so as to impair the public health or seriously to interfere with the convenience and comfort of the people of a great city. We are of the opinion that the Court at Special Term was right in holding that the act is in violation of the Constitutional rights of the plaintiff, and particularly because as affecting it, it would deprive it of its property and of its right to continue, or carry on its business, without due process of law and without making compensation, and because it also impairs the obligation of its contracts with the former cities of New York and Brooklyn, which obligation is transferred by the Greater New York charter to the present City of New York; and also because it appears upon its face not to be an act properly regulating, within the limits of the police power of the State, a business which has heretofore been considered as legitimate and authorized and necessary to the welfare of the community. The act itself does not even refer to that business as one which, for the public health, convenience and comfort, should be altogether suppressed, but such is its effect upon the plaintiff.

CONTRACTS FOR BUILDING THE WESTON AQUEduct of the Metropolitan Water-Works for Boston and vicinity have been awarded to Shanahan, Casparis & Co., Louisville, Ky.; Patrick McGovern, Boston, and Breno, Salamone & Petitti, East Boston. The detailed bids will be found in our issues of last and this week. Some features of the aqueduct are described in our current issue.

TRACK ELEVATION IN CHICAGO is found to be impracticable at one point, and street elevation is proposed in order to eliminate grade crossings. The elevation of the parallel tracks of the Chicago & Northwestern Ry., Chicago, Milwaukee & St. Paul Ry. and Pittsburg, Cincinnati, Chicago & St. Louis Ry. is to extend as far east as Ada St., but it is considered impracticable to continue the elevation further east into the Union Station of the two latter lines, and across the river and into the Wells St. terminal station of the C. & N. W. Ry. Kinzie St. runs parallel with the tracks, and the city proposes to elevate this by a viaduct from Franklin St. to Ada St., connecting with the Halsted St., Desplaines St. and Milwaukee Ave. viaducts which cross the tracks. A branch viaduct will also be built at Canal St., crossing the river by a double-deck drawbridge. Plans prepared by the city engineering department provide for a steel structure having all its members entirely enclosed in concrete. The estimated cost is about $600,000.

THE NEW STONE BREAKWATER AT BUFFALO, N. Y.

The usual type of breakwater used to protect the harbors on the Great Lakes is a timber crib construction, both above and below water level. When the superstructure or part above water decays, it is now common to replace it with concrete.

It is the province of this article to describe a new form of breakwater now under construction at Buffalo Harbor, N. Y. This breakwater is built of stone, with a gravel hearting, and was designed

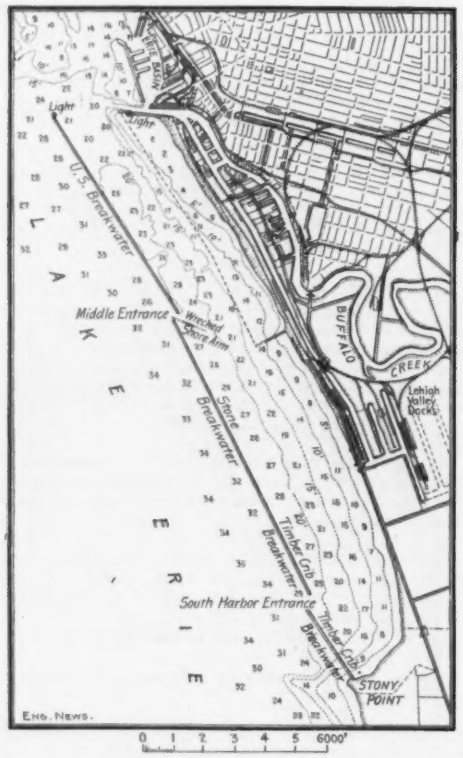


Fig. 1. Map of Harbor of Buffalo, N. Y., Showing Breakwater Extension Under Construction.

by Major T. W. Symons, Corps of Engineers, U. S. A., who is the engineer officer in charge of the Buffalo (N. Y.) district.

Fig. 1 is a map of the harbor of Buffalo, N. Y. The stone breakwater is a part of the project known as the extension to Stony Point, and its location is fully shown by the map. The contemplated length of the stone breakwater is 7,260 ft., of which 1,900 ft. are now fully completed, 1,100 ft. more are in an advanced stage above water level, and 3,000 ft. additional are in more or less advanced stages below water level.

The breakwater is built in water averaging about 30 ft. deep below mean lake level. The usual fluctuations of depth are from about 0.0 to — 1.5 ft., except in cases of severe gales, when they are very much more. During the gale of Nov. 21, 1900, with a westerly wind blowing at the rate of 80 miles per hour, the water rose to + 6.4 ft. at 4.30 o'clock p. m., and at midnight it fell to — 3.0 ft., a variation in 8 to 9 hours of 9.4 ft.

Fig. 2 shows a cross-section of the stone breakwater as it is being constructed, according to the design of Major Symons. It will be noticed that the essential features are the gravel hearting, carried up to — 10 ft., the rubble stone facings built up to — 10 and — 18 ft. on the harbor and lake sides respectively and the heavy revetment and capping stones backed up with rubble stone above these elevations.

The normal width of the breakwater in 30 ft. depth of water is 134.67 ft. and the width of the top is 14 ft. The top is 12.0 ft. above M. L. L. The harbor side slope between the depths of — 10 and — 30 ft. is 1 on 1 and 1-3; and between the depths of — 10 ft. and mean lake level, it is 1 on 0.7045 ±, which is also the slope above water level. On the lake side the slope between the depths of

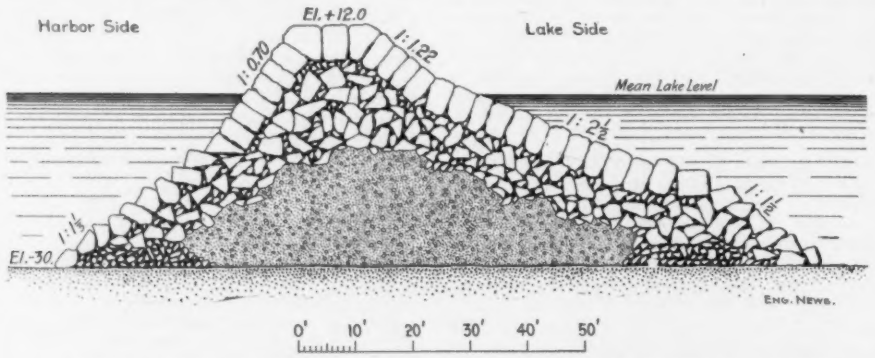


FIG. 2. CROSS-SECTION OF STONE BREAKWATER FOR BUFFALO HARBOR.
Designed by Major T. W. Symons, Corps of Engineers, U. S. A.

— 15 and — 30 ft. is 1 on 1½; between — 15 ft. and + 3 ft., the slope is 1 on 2½, and above that 1 on 1.22 ±.

To insure the requisite stability, a certain breadth of base is required. Had the whole structure been built of stone, its cost would have been very largely increased. In formulating the design it was decided by Major Symons to use gravel for the hearting instead of rubble stone. As gravel can be obtained in the vicinity of Buffalo by dredging at a comparatively small cost, a large saving was effected by the method of construction used. The gravel hearting runs about 36 cu. yds. per linear foot of the structure. The difference in contract price between the rubble stone and gravel is 87 cts. per cu. yd., so that a saving of $31.32 per linear foot was secured by the cheaper and equally effective material. This saving for the whole length of the stone breakwater amounts to $227,383.

Another prominent feature in the construction of this stone breakwater is the regular placing of the large revetment and capping stone to form a kind of giant paving. These large blocks are placed in their positions with remarkable regularity and especially so under water, where the work is done without the aid of divers, the upper surfaces of the blocks varying but little from the prescribed lines, as has been frequently demonstrated by soundings of the completed work. The top angle stones also tend to key the work together and prevent its movement by wave action.

The contractors are Hughes Bros. & Bangs, of Syracuse, N. Y., the contract for the work being signed on Jan. 27 and 28, 1897. The prices paid them for the work are 13 cts. per cu. yd. for the gravel hearting, 80 cts. per ton of 2,000 lbs. for the rubble stone, and $1.25 per ton of 2,000 lbs. for the revetment and capping stone. Active operations on the stone breakwater were commenced on May 16, 1897, and have been in progress for four seasons. The working season is generally from May to December of each year, no work being done during the winter months, on account of ice.

The deposit of the material under water is controlled by suitable piles driven on the axis of the breakwater and by cross-ranges placed at 1,000 ft. intervals. Fig. 3 shows one of these cross-ranges.

The axis of the breakwater is permanently fixed

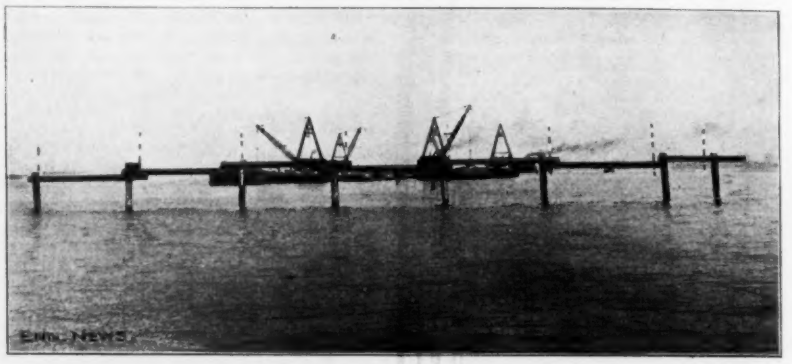


FIG. 3. CROSS-RANGES FOR CONTROLLING DEPOSIT OF MATERIAL.

by two targets, one on the old breakwater and the other on the shore at Stony Point. (See Fig. 1.)

DEPOSITING THE GRAVEL AND RUBBLE STONE.

In constructing the breakwater the first work is the building of the lower lake and harbor slopes. The lower portion of these slopes is composed of small rubble stone, and is either deposited by casting the same from canal boats by hand, or by dropping them from dump scows, the vessels being properly aligned by means of the ranges above mentioned. The material so deposited forms ridges with a triangular cross-section. After these ridges have reached a height of about 6 ft. above the lake bottom, the gravel is next deposited between them by means of dump scows, keeping the gravel about 3 ft. below the apex of the ridges, making a 3 ft. course of gravel.

The gravel is dredged from the bed of the Niagara River, near the International Bridge, and is brought to the work in dump scows, carrying about 450 to 500 cu. yds. Owing to the strong current of the Niagara River, from 6 to 8 miles per hour, a tug boat of more than ordinary capacity had to be built for towing, the regular harbor tugs at Buffalo not serving the purpose satisfactorily.

The next work consists of the depositing of larger rubble stone on top of the ridges of the smaller stone. Care had to be taken to keep this large rubble stone below the — 10.0 ft. level on the harbor side, and below the — 18.0 ft. level on the lake side. This large rubble stone is deposited by means of dump scows and the depositing is regulated by the ranges before mentioned.

The gravel hearting follows closely the rubble stone. After the rubble stone has reached the proper height on the lake side, the position of the dump scows is so regulated that an offset or horizontal berme is formed, and on this berme the initial course of the revetment stone is placed. After the gravel hearting has reached a level of — 10.0 ft. it is covered with rubble stone. In this depth of water but little stone can be placed by dump scows, and the remainder is placed by derrick scows unloading from deck scows.

PLACING THE REVETMENT.

The next operation in the work is the placing of the revetment stone. The first course of stone on the harbor side is a skewback or angle stone. The beds of these stones are placed upon a prepared foundation, the top of which is 10 ft. below

M. L. L. These stones are set by means of suitable ranges, as shown in Fig. 4, and their placing is directed by an observer using a water telescope. Each one of these skewback stones is placed with its apex at the correct distance from the axis of the breakwater and at the proper depths below the surface. The top bed of the skewback stone, or angle stone, as it is called, is such that it is at right angles to the harbor side

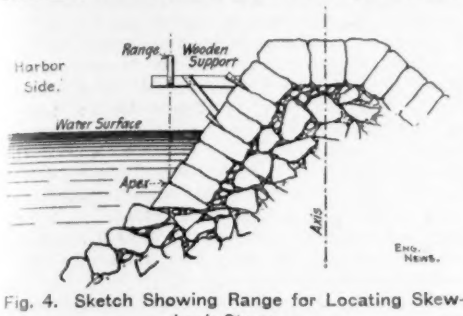


Fig. 4. Sketch Showing Range for Locating Skewback Stones.

slope. As long a stretch as possible of these stones is set in advance, the other courses following in succession. Usually two or three courses bring the work out of water.

On the lake side the first course is placed with the beds in a horizontal position, on a range 63 ft. from the axis of the breakwater. The next course of stone is placed at right angles to the slope, the stone being so hung from the hooks so as to attain this position. It may be stated here that before the revetment stone on the lake side are set a rubble stone foundation conforming as closely as possible to the prescribed section is built by dropping stone from a deck scow, the edge of which is placed parallel to the axis of the breakwater and at known distances from the same. Work of this sort in progress is shown by Fig. 5. The leveler in charge of this work is furnished with a table showing the required depths for every 2 ft. horizontal interval. By constantly sounding with a pole and making allowance for the stage of water, as shown by an adjacent gage, a quite regular slope is obtained.

FIG. 5. DEPOSITING RUBBLE STONE FROM SCOWS.

A copy of part of the table used by the leveler in his work is given herewith.

Table Used by Leveler in Charge of Deposit of Rubble.

Below mean lake level.							
Lake side.				Harbor side.			
Finished rubble stone.		Capping and revetment.		Finished rubble stone.		Capping and revetm't.	
Distance, center range.	Depth, ft.	Distance center range.	Depth, ft.	Distance, center range.	Depth, ft.	Distance, center range.	Depth, ft.
12.2	0.0	25.5	0.0	8.0	0.0	15.5	0.0
14.0	1.5	28.0	1.0	9.0	1.3	16.0	0.9
16.0	2.7	30.0	1.8	10.0	2.8	17.0	2.3
18.0	3.5	32.0	2.6	11.0	4.2	18.0	3.7
20.0	4.3	34.0	3.4	12.0	5.7	19.0	5.1

As on the harbor side, water telescopes are used as an aid in placing the revetment stone.

THE WATER TELESCOPES.

The work is greatly aided by the use of these water telescopes. Three of them are in use, in lengths of 7 ft. 4 ins., 9 ft. 10 ins. and 12 ft. 4 ins., respectively, and weighing 171, 222 and 301 lbs. These weights are somewhat less than the displacement of the tubes, allowing them to float about 2 ft. out of the water. To obtain the proper buoyancy the tubes were made slightly under weight and iron rings were afterwards added to adjust them to the proper flotation depth.

The longest telescope is made of four steel plates, of which two or 3-16-in., one ⅛-in. and one 1-16-in. thick, the upper and lower plates are each 3 ft. ¾-in. long and the middle ones 3 ft. 1½ ins.. The plates are riveted together and made water tight. The tube is 12 ins. in diameter at the object end and 4 ins. in diameter at the eye end, fitted with hooks and handles for raising and lowering. An iron casting is riveted on the object end of the tube, projecting 4 ins. beyond the latter. The casting is provided with planed seats for a plane object glass 13 ins. in diameter and ½-in. thick, and for the rubber packing and ring necessary to make watertight joints.

The medium sized telescope is similar in construction, except that it is composed of three plates instead of four. The smallest telescope is made of one plate. The larger and smaller diameter is the same for all telescopes, the one casting being used for all. The telescopes are also provided with a rubber ring at the smaller end, to prevent injury to the eye of the user. Figs. 6 and 6A show one of the telescopes.

METHODS AND MACHINERY USED IN PLACING REVETMENT STONES.

The preparation of the lake side slope of rubble at the inception of the work is usually confined between ranges 63 ft. and 40 ft. from the axis, the depth of water over the foundation at 40 ft. being 12.3 ft. M. L. L., and for the finished revetment stone 5.8 ft. The reason for this is that at a shallower depth the foundation is likely to be disturbed by the action of the waves during heavy storms, and also to allow partially loaded scows to get closer to the work while unloading in the center of the breakwater. The practice has therefore been to lay as long a stretch as possible of revetment stone between the limits mentioned during favorable weather. All the revetment stones below the water surface are laid with the utmost care, especial pains being taken to place the initial course parallel with the axis of the structure. This is readily accomplished by means of the ranges previously described. Each stone, after being lowered into the water onto the rubble stone foundation, is carefully inspected through a water telescope before the lifting chains are slacked, and if not in its proper position as to range and direction, it is then maneuvred until it is so. All stone under water are placed in close contact with each other, which is quite essential to prevent the smaller pieces of foundation stone from being washed out through wide joints.

The accompanying table, taken from Major Symons' annual report for 1900, shows the amount of revetment and capping stone placed in the work during the latter half of the season of 1899; also details of the number of stones and weights of same:

Work on Buffalo Breakwater; July-December, 1899.

1899.	Placing				Weight	
	Working days.	Revetment and capping stone, tons.	Daily, tons.	No. stones.	Average, tons.	Maximum.
July	26	7,573.7	291.3	1,217	6.22	14.2
August	27	9,056.7	335.4	1,396	6.48	17.0
September	26	6,062.1	233.2	846	7.16	16.2
October	26	6,367.8	244.9	919	6.93	15.0
November	26	2,881.2	110.8	419	6.87	15.8
December	11	1,512.4	137.5	253	5.97	17.0
Total and ave..	142	33,453.9	235.6	5,050	6.62	17.0

THE FLOATING DERRICKS.

All the revetment and capping stones are set by means of large floating derricks, of which the contractors had five in service during the season of 1900. One, however, was used exclusively for placing rubble stone and for doing other work. The dimensions of these floating derricks are as follows:

	Hull.			
No. 5	28 ×	90 ×	8.5 ft.	50 ft. stiffened wooden boom.
No. 6	34 ×	90 ×	8.5 "	60 " steel lattice boom.
No. 7	34 ×	90 ×	8.5 "	60 " " " "
No. 15	34 ×	111 ×	11.0 "	75 " " " "
No. 17	34 ×	111 ×	11.0 "	60 " " " "

Derricks Nos. 5, 6 and 7 are built on scows specially constructed. Nos. 15 and 17 are built on

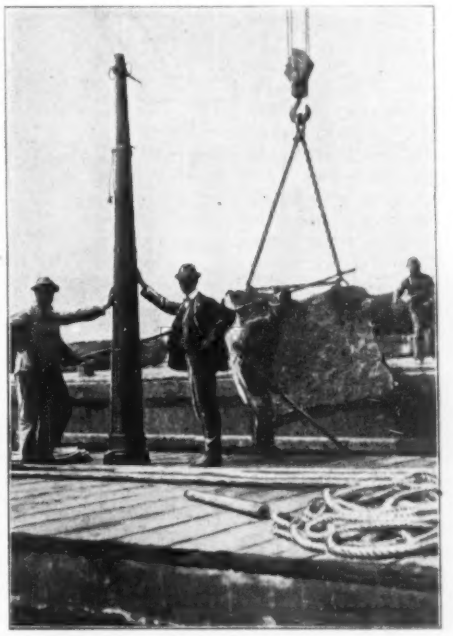


Fig. 6. One of the Water Telescopes.

dump scows, the coamings having been torn out and a floor built over the pockets. Fig. 7 shows side and end elevations of derrick No. 15.

The shear legs are made of pine 14 × 16 ins. in section. Each leg is reinforced by two pieces of pine timber at the lower end, one 14 × 16 ins. and the other 10 × 16 ins. The back legs are 10 × 12 ins, on pine sticks. The height of the frame is 51 ft. above the lower end of the boom, which is set about 2 ft. below the deck level.

The shear and back legs are bolted to the cross timbers of the deck and sides of scow at their lower ends, but at the upper end they are simply inserted into sockets in the single steel head casting, which carries the pin, so they take only compression. The tension for each timber is taken by two 1½-in. rods, attached to the head casting by devises and to the side of the hull by straps and provided with turn buckles.

The back legs are stiffened by means of struts extending from the middle to the lower end of the shear legs.

The boom is of lattice steel construction of 5 × 3½ × ⅜-in. angles, with 5-in. horizontal dimensions, with lattice bars 4 × ½-in at the center, decreasing to 3 × ½-in. and 2½ × ½-in. towards the ends, with ⅝-in. plates at the ends and steel castings to hold the pins. The swivel casting or bootjack at the lower end rests on a single steel casting with 5-in. vertical pin and carries the boom on a 3½-in. horizontal pin. The hoisting fall has a single block, with 15-in. sheave, the ⅝-in. steel cable passing over the 30-in. sheave at the outer end of the boom.

The boom fall has two blocks with two 15-in. sheaves and ⅝-in. cables. (The ⅝-in. cables are being replaced by ¾-in. cables.) The boom is swung by ⅝-in. cables on each side leading from the outer end of the boom through a single block attached to the side of the scow 5 ft. forward of the foot of the boom, 45 ft. from the foot, thence to a block between the shear legs. The hoisting engine is a double-cy-

linder, double friction drum Lidgerwood, with boiler and fixtures, ratchets and pawls complete. The cylinders are 8¼ ins. in diameter and 10-in. stroke.

The swinging engine is a double-cylinder, double friction drum Lidgerwood, with ratchets and pawls, but without boiler. The cylinders are 6¼ × 8 ins. The engines work at 100 lbs. pressure.

The other derricks have steel booms only 60 ft. long, built somewhat lighter, of 3½ × 3½ × ⅜-in. angles and fitted with engines and cables the same as No. 15.

The lifting power of these derricks is about 20 tons.

The revetment and capping stone is brought to the work on deck scows, which are towed from the Canadian quarry by tug boats.

In setting the revetment and capping stone the floating derrick is placed broadside to the work. The loaded scow of stone is placed alongside the derrick on the outside. When engaged in setting revetment stone on the lake side, small floats averaging about 14 × 20 ft. in size are placed between the floating derrick and the work. These floats serve as a base for the workmen, who manipulate the swinging stone and also for the government inspector overseeing the operations. Fig. 8 shows this work in progress. After the revetment has been placed to range 40 ft. from the axis of the breakwater, another area of foundation is prepared, reaching usually to the water surface.

The placing of the revetment is then resumed, and as the stone construction approaches the water surface care is exercised to obtain as straight a "shore line" as possible and one parallel to the axis of the work. Above water level the stone is set by means of wooden templates conforming to the prescribed section. One of these is shown in Fig. 9. The top of the stone breakwater consists of two angle stones with an intermediate filler. These angle stones are quarried to patterns, one for the lake top corner and the other for the harbor top corner. The revetment and capping stone range in weight from 4 to 17 tons, averaging about 7 tons.

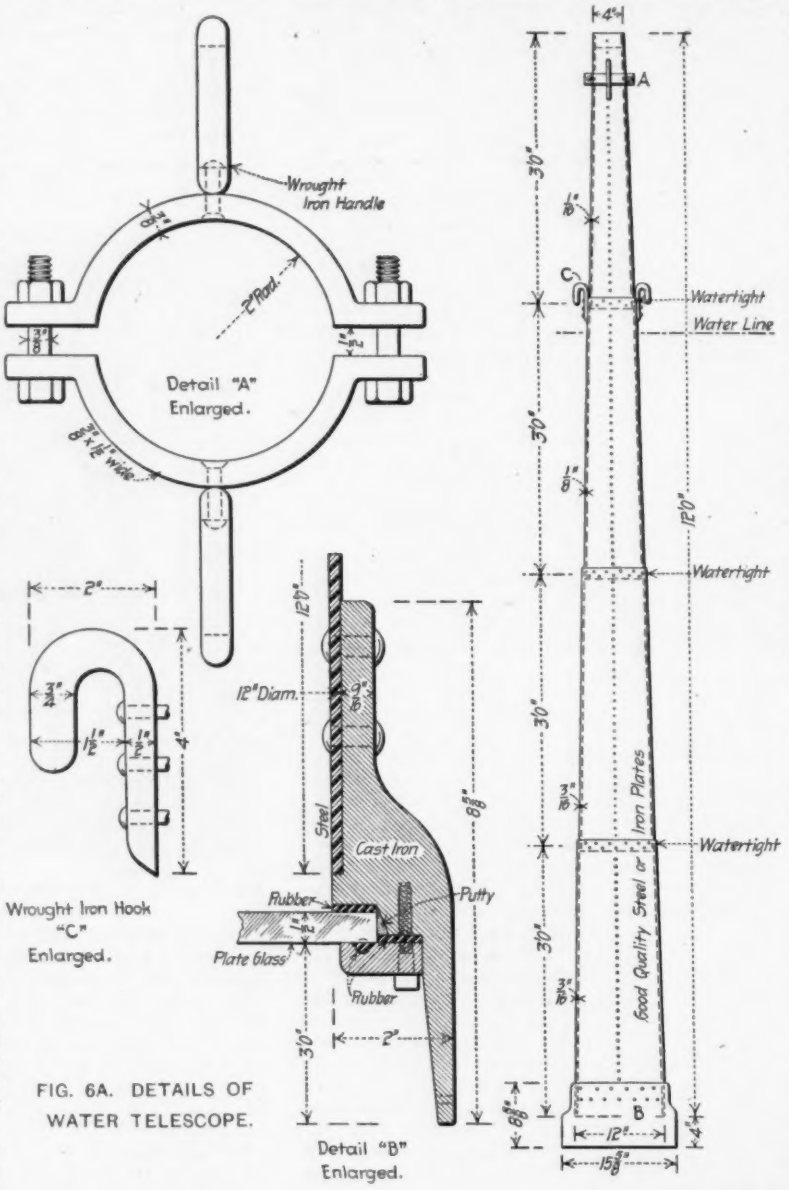


FIG. 6A. DETAILS OF WATER TELESCOPE.

The prevailing winds at Buffalo are from southwest, and cause seas varying in size according to their velocity. With a strong southwest wind blowing no work can be done on the lake side and much working time is lost for this reason.

RECORDING AND MEASURING THE CONTRACTORS' WORK.

A complete record is kept of all material placed in the work, showing the kind and where placed when placed. The work is divided into 1,000 ft. sections of 10 stations, each 100 ft. long, a pile being driven every 1,000 ft., with the necessary cross-piles. The system of intermediate rangepiles or piles has been changed nearly every season, as exigency or experience has dictated. During the season of 1897 the intermediate piles were driven at the foot of the side slopes at intervals in one case of 250 ft. and in another instance at 200 ft. This arrangement was abandoned, as it interfered with the dumping of the gravel, the scows carrying the same being 175 ft. long.

The next season, 1898, piles were only driven on the axis of the breakwater at 250 ft. intervals and latterly only at 500 ft. and 1,000 ft. intervals.

The longitudinal position of the scow when dumping material is ascertained by a measuring line made of 1-16 to ⅛-in. galvanized cable with a hemp center. The longer lines are 1,000 ft. long or more, and are marked every 20 ft. by a wire loop, to which wooden blocks or floats are attached by small harness snaps. These floats are needed to keep the wire from sinking. The shorter lines have loops every 10 ft., into which small round brass markers are fixed. The markers are stamped 1, 2, 3, representing multiples of 10 ft. All the lines are provided with reels.

As all the material deposited under water is hidden from view, it is of the greatest importance to know its exact position, and for that reason, as stated above, a complete record is kept. So complete are these records that the exact position of any scowload of material placed in the work during the past four seasons can be given after a few minutes' search.

Each inspector has a book of tickets, and one of these is filled out by him and issued for each and every scowload of material of whatsoever sort used in the work. Each of these tickets shows in detail the load of the vessel and exactly where the load was deposited.

A CATAMARAN SOUNDING SCOW.

To further determine the status of the work unde water, the same is thoroughly sounded. The sounding is all done from a scow specially constructed for the purpose. As the structure is 135 ft. wide, and all the material below water surface is put in rapidly, mostly from dump scows, the soundings must be quickly taken and plotted into cross-section books, in order to locate the next rows of scows properly.

A scow 20×50 ft., which was first employed, was found quite inadequate for the purpose, as it was necessary to line up this scow three times to cover the whole width of the work. A new scow

FIG. 8. PLACING REVETMENT STONE.

FIG. 8A. DEPOSITING A SKEWBACK STONE.

was therefore constructed during the first season which would give four sections clear across the work 10 ft. apart each time the scow was lined up, the soundings being taken 5 ft. apart on the line of the section. The construction of the scow is shown by Figs. 10 and 11. The scow is built with two hulls, each 10 ft. wide and 120 ft. long, separated by a narrow space 10 ft. wide, thus forming a catamaran. The hulls are built of only 3 ft. depth, in order that the deck may be as low as possible to facilitate the sounding operations. The hulls are connected together by the head block at each end, and also by 14 intermediate cross-timbers, the lower ones being 12 × 12 ins. in cross-section and the upper ones 8 × 12 ins. These cross timbers extend the whole width of the scow. Each hull is provided with suitable iron truss rods and bracing to secure stiffness.

The bottom planking is of 3-in. stuff placed longitudinally. The deck is made of the same material laid transversely. Two deck houses, each 7 ft. 6 ins. × 10 ft. in size are built on the scow, one to serve as a plotting and computing room and one as a storehouse for lines, etc. The scow is also provided with four crank capstans one at each corner, for handling anchor and mooring lines, which lead to anchor buoys distributed along each side of the works at convenient distances. A small travelling crane, running on a track of 6 ft. gage, is also provided to handle an iron pipe sounding rod, used to determine rock when employed on other work.

To operate the scow, a force of 4 laborers and a sounder are required, working under the direction of an inspector. The vessel is most appropriately named the "Gemini." Fig. 12 shows the method of plotting the soundings to record the progress of the work.

MEASURING THE VESSELS USED IN CARRYING STONE.

All the small and ordinary rubble stone and revetment and capping stone are paid for by the ton of 2,000 lbs. All vessels used for the transportation of this material (and this includes deck and dump scows and canal boats), are provided with glass gages and graduated rules, by which the draft of the vessel is ascertained. A number of the deck scows were built especially for the work and exact measurements of these vessels were made before launching. From the data thus secured elaborate tables were prepared showing the displacement for every 1-100 of a foot, calling the bottom = zero.

The glass gages mentioned above are placed on the keel forward and aft, and consist mainly of a wrought iron standpipe 3 ins. in diameter, into which two brass cocks are screwed. Between the cocks, which are from 4½ to 7 ft. apart, depending on the size of the scows, is placed a glass tube about 1 in. in diameter, the whole apparatus resembling a water glass gage as used on a boiler. A wooden rule graduated in feet, tenths and hundredths is attached alongside of the glass tube.

The graduations of the rule correspond exactly with the draft of the vessel. This is usually accomplished by taking the mean draft of the vessel fore and aft and setting the rule to correspond with the water in the gage. Absolutely quiet water is required for this work, and to facilitate it marks 6 ins. apart are accurately cut into the sides of the vessels at each end. To determine the load of a vessel, the mean readings of the gages are taken when the vessel is light and again when loaded, the difference between the light and loaded readings as taken from tables giving the desired information. Vessels which cannot be measured on the ways or in docks are measured on the water, their draft being obtained by hook gages.

To check the calculated displacement, the load of a vessel is actually weighed at frequent intervals, by means of a track scale, located at the contractors' Canadian quarry. Remarkable agreements are found between the two.

In the case of dump scows it is not possible to obtain the load carried by displacement, and the value of the gage readings is, therefore, determined by actually weighing the material on the track scale, the readings of the gage being taken when the scow is light, and with frequent partial loads and when fully loaded. The difference in feet and decimals of the gage readings divided into the total load gives the ratio per foot. This only applies to full loads. Partial loads, as well as large or small-sized stone affect this ratio somewhat.

SOURCES OF THE STONE USED.

During the first season's work, 1897, the cubic contents of each canal boat load of small rubble stone from the Lockport limestone quarries, as well as the tons carried, was carefully noted. It is interesting to note that 1 cu. yd. = 1.125 tons. This stone weighs generally 165 lbs. per cu. ft. From similar measurements made of Medina sandstone it was found that 1 cu. yd. = 1 ton, this stone weighing 152 lbs. per cu. ft., and the voids being for each about 50%.

The small and ordinary rubble stone used in the construction of this breakwater has been obtained from two main sources, one being the quarries along the line of the Erie Canal, in the vicinity of Lockport and Albion, N. Y., and the other, the Canadian quarry, near Windmill Point, Ontario.

The stone from near Lockport is limestone, and was obtained from the spoil banks located on both sides of the Erie Canal, the same being the material excavated from the prism of this canal during its construction. This stone is of excellent quality. It was re-excavated, mostly by bars, and loaded into canal boats by a McMyler derrick. The boats were towed to Buffalo by a tug in tows of 3 boats daily. The stone obtained from near Albion is a sandstone, known as Medina stone, and is of somewhat less weight than the Lockport limestone. It is also brought to Buffalo by canal boats. The major portion of the rubble stone, as well as all of the revetment and capping stones, is obtained from the Canadian quarry, owned by the contractors, on the north shore of Lake Erie, near Windmill Point, Ontario. It lies about 5 miles west from the Buffalo Breakwater light.

THE WINDMILL POINT QUARRY.

Fig. 13 is a ground plan of the quarry showing the status of the same on May 1, 1900. The to-

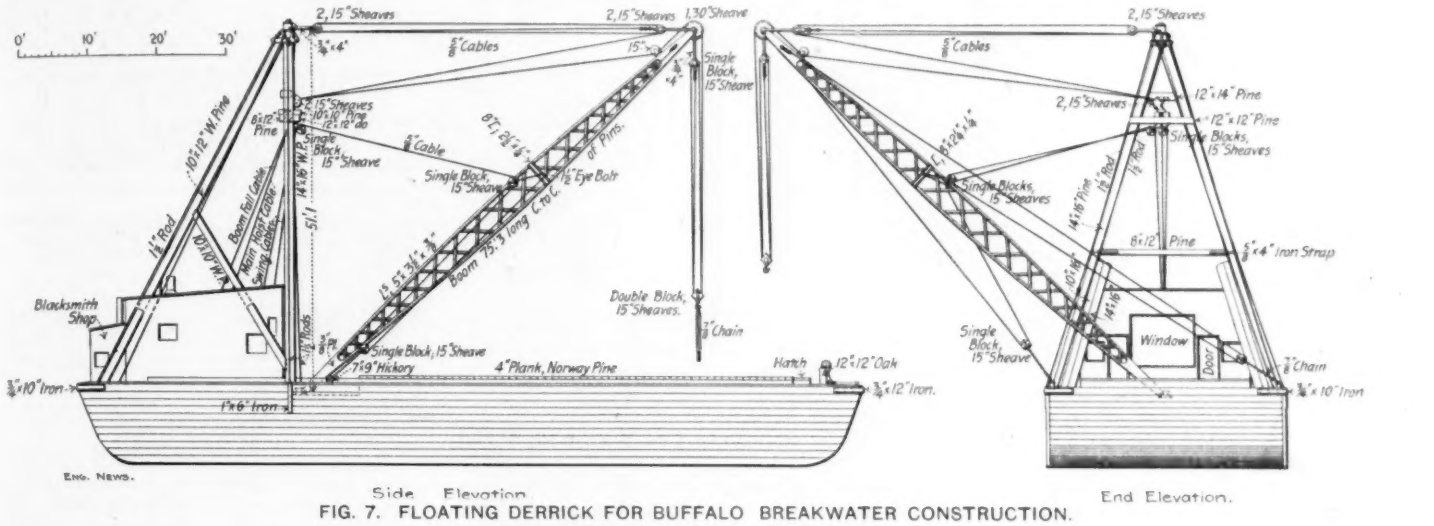


FIG. 7. FLOATING DERRICK FOR BUFFALO BREAKWATER CONSTRUCTION.
Hughes Brothers & Bangs, Contractors.

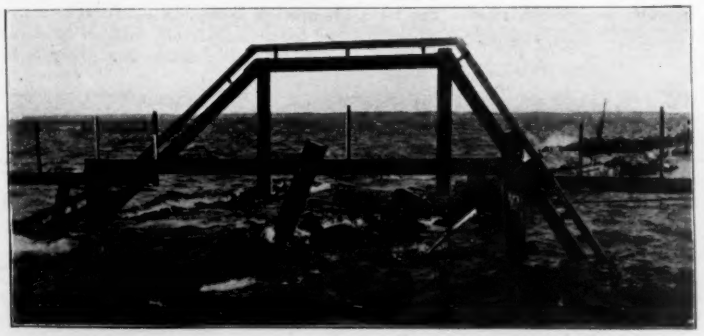


FIG. 9. TEMPLATE FOR PLACING STONE ABOVE WATER LEVEL.

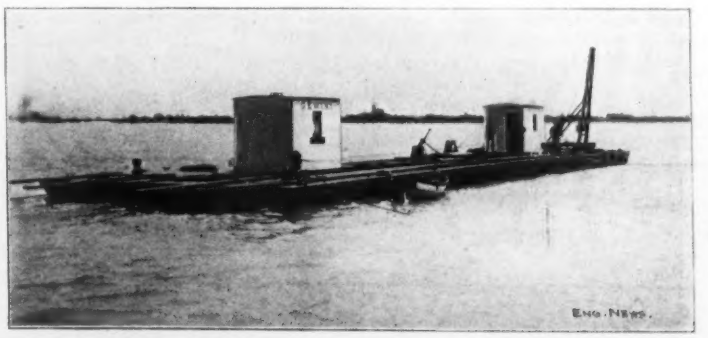


FIG. 10. CATAMARAN SOUNDING SCOW FOR BUFFALO BREAKWATER WORK.

pography of the land, on which the quarry is located, is level, the underlying rock being covered with but a thin layer of soil, ranging from 1 to 4 ft. in depth, the stone being thus obtained from below the level of the surrounding ground. The work of stripping the earth from the site of the quarry was begun in May, 1897. This stripping extended in an easterly and westerly direction, and was made about 100 ft. in width, and about 500 ft. long.

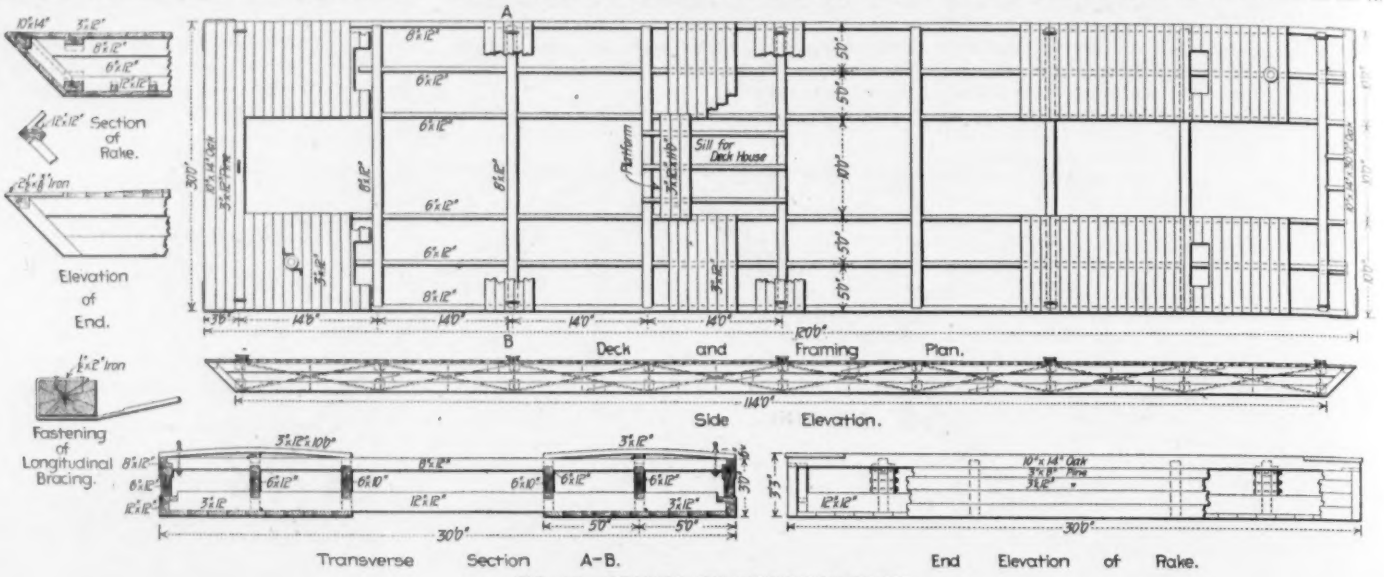


FIG. 11. DETAILS OF SOUNDING SCOW.

In opening the quarry the plan pursued was to make as rapidly as possible an excavation about 30 ft. deep, and approximately 100 ft. in width. To do this effectually, very heavy charges of dynamite were used in blasting, which resulted in breaking up the rock into very small fragments, making much of the quarried material useless for breakwater construction. Much of it, however, was used by the contractors for filling the cribs of their loading dock, ballasting track and other purposes.

While the quarry was being opened, the loading tracks were located on the top of the south side of the quarry. Between these tracks and the quarry the loading derricks were placed. After the bed of the quarry had reached the contemplated depth of 30 ft., the loading tracks and derricks were removed to the bottom. An inclined plane was also built, over which the empty and loaded cars passed to and from the quarry. The railroad tracks extend from the quarry to the loading dock at the lake shore. The gage of all the tracks is 3 ft.

The rock composing the quarry is a stratified limestone, dark gray in color, hard and brittle in texture and weighs about 166 lbs. per cu. ft. The thickness of the different courses varies considerably in the length of the quarry. The stone is taken out in four ledges.

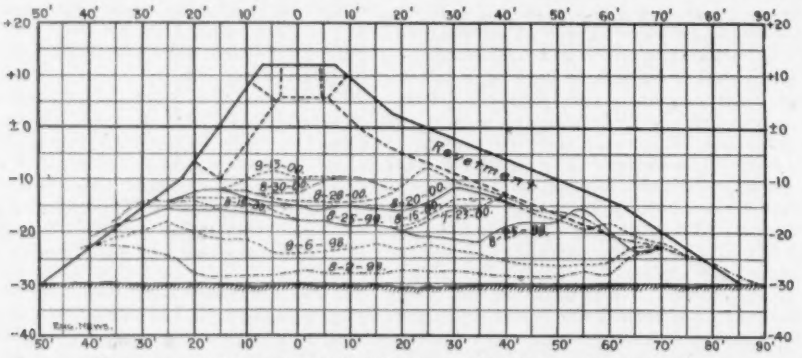


FIG. 12. ONE OF THE GRAPHICAL RECORDS OF SOUNDINGS.

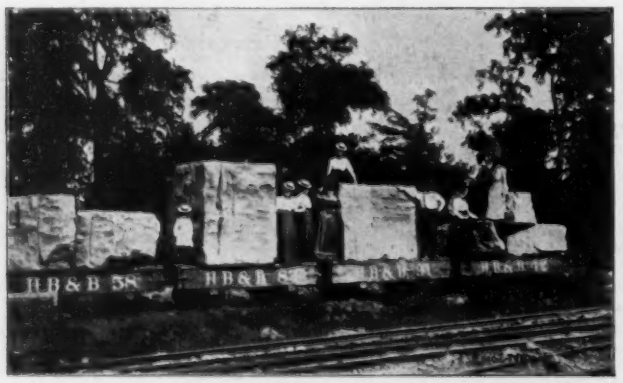


FIG. 16. REVETMENT STONES FOR BUFFALO BREAKWATER EN ROUTE TO THE LOADING DOCK.

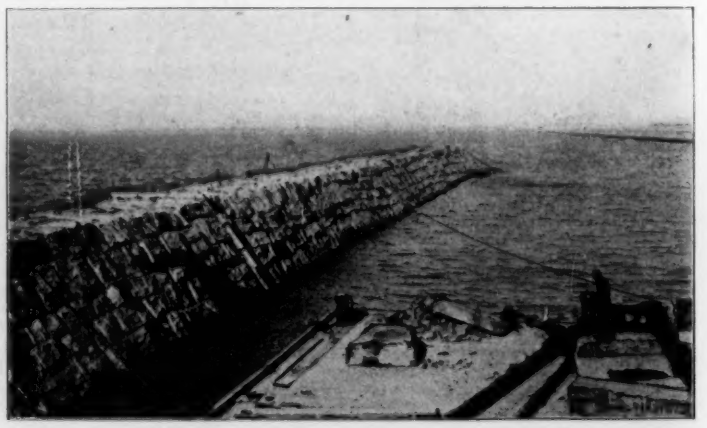


FIG. 17. VIEW OF COMPLETED PORTION OF STONE BREAKWATER, HARBOR SIDE.

At the middle of the north side of the quarry, or near the angle, the first ledge is from 20 to 36 ins. in thickness. It is of rather poor quality owing to the weathering it has undergone. The ledge below is about 9 ft. thick, decreasing to 6 ft. at the east end. The next ledge varies from 7 ft. in thickness at the west end to 10 ft. at the east end. The next ledge is more uniform in its thickness, which is about 5 ft. Under this is what is called the flint course. It is from 6 to 7 ft. thick at the west end, but at the east end of the quarry but little of it is taken out, as the grade of the bottom of the quarry rises for the incline, which is located at the eastern end.

METHODS OF WORKING THE QUARRY.

In quarrying, the face is worked in four ledges. To quarry the first or top ledge a line of holes is drilled 18 ft. back from the face. The holes are spaced 3 ft. 10 ins. apart on an average, and are drilled to within 6 ins. of the bottom of the ledge. The number of holes in one spot varies from 50 to 65. An attempt is made to start and end at a seam, so the ledge can move out without being broken up. These seams occur at irregular intervals, and at an angle of about 45° with the face of the quarry.

Ingersoll-Sergeant steam drills are used, the sizes being the F, large, C medium, and pony.

The largest size will drill about 75 ft. a day, the medium size about 60 ft., and the smaller size, or pony drill, about 35 to 40 ft.

When the holes are first started, a 2¼-in. drill is used; when this has been driven to a depth of 3 ft., the bit has worn away about ¼-in., so that the next bit used is 2 ins., being reduced so as to fit where the last one left off, and so on down, a reduction of ¼-in. being made for every 3 ft. in depth. The usual diameter at the bottom is 1¾ ins.

After the holes are drilled to the required depth, they are rimmed with a rimmer which changes the

circular cross-section of the hole to an elliptical one, with the longest diameter in the line of the holes. The rimmer is a diamond-shaped steel tool, and is either driven into the holes by hand or by means of a steam drill. The object of the rimming is to produce a line of rupture between the drilled holes.

Powder is used for blasting. In charging, 3 or 4 handfuls of powder is placed in the bottom of each hole, the exploder is then put in, and a little

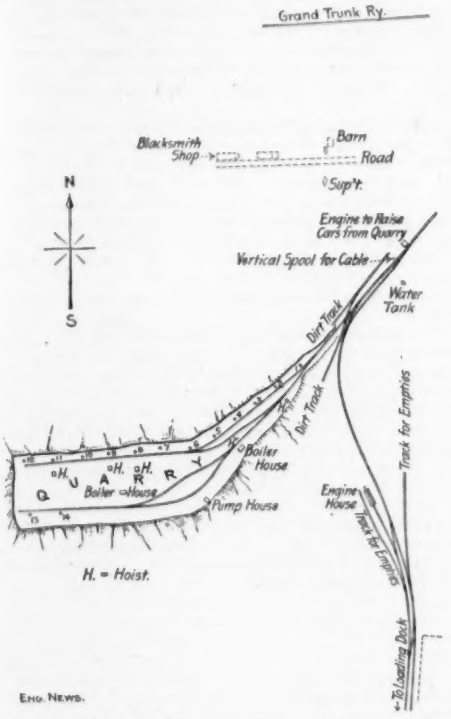


Fig. 13. General Plan of Quarry at Windmill Point, Ont.

more powder on top of that. Then a wad of grass is forced down, leaving an air-space of 2 or 3 ft. above the charge. The hole above the wad is then tamped full of clay. Dry sand is sometimes used instead of clay for tamping, and gives very good results and saves a good deal of time in loading. It is also much easier to remove the tamping in case a charge fails to explode. To clean out a charge a steam hose is attached to a small pipe and steam is blown into the hole, water also being let in; the charge is thus blown out.

On Wednesday, Oct. 24, 1900, a block of stone 180 ft. long by 18 ft. wide, with an average thickness of 9 ft., was blasted off the second ledge at the eastern end of the north face of the quarry. This block contained 29,160 cu. ft., and weighed 2,430 tons.

To loosen this mammoth stone, a line of holes 8 to 9 ft. deep was drilled, about 18 ft. from the face of the top ledge and about 3 ft. 6 ins. apart. There were 52 holes in the line, and 3 kegs, or 75 lbs., of powder was used. Sand was used to tamp the holes instead of clay. The 52 holes were loaded in one hour, where it would have taken at least 2½ to 3 hours to tamp with clay.

The block described above was moved out about 2 ft.

On October 1, 1900, a top ledge 18 ft. wide, 250 ft. long, and about 9 ft. thick, was shot off. Sixty-four holes were used, requiring nearly 150 lbs. of powder. The ledge weighed about 3,375 tons, and was moved out from 2 to 3 ft.

After these large blocks are separated from the ledge, they are split up into square or angle stones of any size and shape desired, by drilling holes along the desired line of fracture, and using either light powder charges or plug and feather.

The second and third ledges are worked in the same manner as the first. The fourth or flint ledge is used entirely for rubble stone, and is blasted out with dynamite.

MACHINERY USED AT THE QUARRY.

Steam for the drills is furnished by 5 horizontal boilers of 50 HP., working at 75 lbs. steam pressure. These boilers are located about 50 ft. from the face of the quarry on top, and a steam pipe runs from them to and along the edge of the quarry, feeding the drills by short connecting pipes. Water for the boilers is furnished during warm weather by a 6 × 4 × 6-in. Worthington steam pump, located at the loading dock, about a mile distant. The supply pipe is 2 ins. in diameter. The capacity of the pump is from 70 to 100 gallons per minute. In freezing weather, however, water from the lake is shut off, and water is taken from the quarry pit by two Worthington pumps, one 7½ × 7½ × 6 ins., and one 7½ × 5 × 6 ins., with a capacity of 300 and 100 gallons per minute, respectively. These are also used to keep the quarry free from water. The larger one is used only in case of necessity. The hoisting in the quarry is done by 7 skeleton engines, each 8¼ × 12 ins., of 20 HP., and one engine with a boiler of 16 HP. Each engine works two derricks, and simply does the hoisting of the blocks of stone, the boom being swung and lowered by hand. Two horizontal boilers of 50 HP. furnish steam for the skeleton engines.

To draw the cars up the incline, a 7 × 10-in. engine of 18 HP., geared to a winding drum, is used. Usually 12 loaded cars are drawn up at a time. At the dock two similar engines are used to operate two hoisting derricks in unloading stone from cars to scows.

The stone is transported from the quarry to the loading dock on flat cars. The capping stone is loaded direct onto the cars, while the rubble stone is first loaded into skips, which are then transferred to the flat cars. The bed of the flat cars is 5 ft. wide and 10 ft. long, and is 2 ft. 9 ins. above the top of the rail. The 4 wheels on two axles are each 2 ft. in diameter. All timber is white oak. The side frames are 6 × 10 ins., the end pieces 4 × 9 ins., projecting 4 ins. above the side pieces. The center cross-pieces were of this same size, but were found to be too weak, and were changed to 6 × 9 ins. These cars were built by the Union Car Co., of Depew, N. Y.

The skips or boxes used for carrying rubble stone are made of 2-in. white oak plank, heavily ironed. These boxes are 7 ft. long on top, 5 ft. on the bottom, 5 ft. wide and 2 ft. deep, with a square end. They carry from 3 to 4 tons of rubble stone.

The loading dock, including the approach, is about 1,200 ft. long, from the shore to the outer end. As originally built, it consisted of a series of isolated timber cribs connected by stringers. The cribs are built of hemlock timber, 20 ft. wide and 22 ft. long, the depths varying with the depth of the water, which at the outer end of the dock is about 14 ft. deep. The cribs are filled with stone and are wide enough for two tracks. The spans between cribs is 20 ft., and the track stringers, of which there are two under each rail, are 24 ft. long, 8 ins. wide and 12 ins. deep.

Fig. 18. North End of Stone Breakwater Completed.

Since the cribs have been sunk, part of the approach for a distance of 400 ft. cut from shore has been filled in with debris from the quarry.

The loading dock proper at the outer end is about 365 ft. long, and consists of cribs placed end to end, with heavy riprap on the west or seaward side. At the extreme end there is also an L-crib, serving as a protection. There are two engine houses, placed on separate cribs, while two loading derricks are placed on the edge of the dock.

On arrival of the different classes of stone at the loading dock, the material is transferred to scows by the two derricks mentioned above.

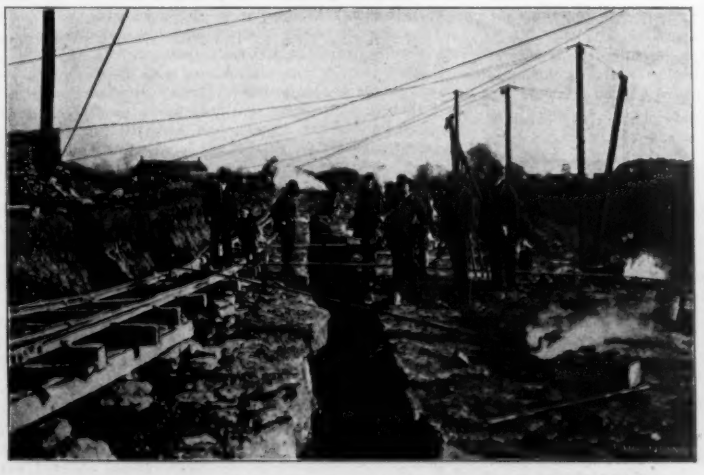


FIG. 14. VIEW AFTER A BLAST AT WINDMILL POINT QUARRY, SHOWING MOVEMENT OF HUGE BLOCK OF STONE.

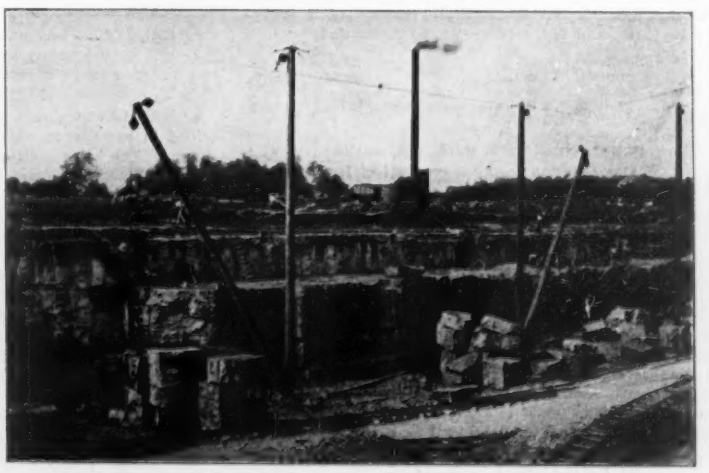


FIG. 15. GENERAL VIEW OF WINDMILL POINT QUARRY.

The small scows are 28 ft. wide and 90 ft. long on the deck, with 8½-ft. sides, and draw, when light, 1.7 ft. With a draft of 7.2 ft., or a displacement of 5.5 ft., they carry a load of 423.3 tons.

The large scows are 32 ft. wide, 130 ft. long on the deck, the sides being 9½ ft. high, and they draw, when light, 2 ft. With a draft of 8.5 ft., or a displacement of 6 ft., they carry a load of 791.3 tons.

The loaded scows are towed by tugs to the breakwater site.

The average daily output of the Canadian quarry is about 800 tons of rubble stone, and about 300 tons of revetment and capping stone.

The writer of this article, Mr. Emile Low, M. Am. Soc. C. E., has from the beginning been the resident engineer in charge of the work.

SPECIFICATIONS FOR STEEL RAILS.*

By W. R. Webster.†

Opinions still differ widely concerning the requirements, chemical and physical, which should be expressed in specifications for steel rails, in order to secure results satisfactory to both manufacturers and purchasers. Sir Lowthian Bell is reported as saying last summer, at the London meeting of the American Society of Civil Engineers, that

as he had been 25 years a manufacturer of rails, and 25 years a director in the Northeastern Ry., he represented both maker and user, and he had at his disposal 35,000 analyses to go upon, in making deductions. From these he could prove, and disprove, everything that could be said for or against any composition of a rail—a facility beloved by the expert.

The Committee of the British Board of Trade adopted in its report of May, 1900,‡ the following, with other conclusions submitted by Sir William Roberts-Austen and Professor Unwin:

The evidence before the Committee indicates what the limiting proportions of carbon, sulphur, phosphorus, manganese and silicon should be. As regards the influence of phosphorus, it is pointed out that, in a broad sense, brittleness of steel does not depend on the total amount of phosphorus present, as that element may exist in steel in at least two different forms, one of which is comparatively innocuous. It is very important that all who are responsible for the manufacture or use of steel rails should realize that steel is not the homogeneous mass it is often supposed to be, but possesses a complex structure. The nature of this structure will vary greatly with the mechanical and thermal treatment to which the metal has been subjected. The durability of the rail depends in no small measure on its structure, which may, if the specimens of steel have been suitably prepared, be revealed by the microscope. The peculiar structure of the St. Neots rail, for instance, can be exactly imitated.

Also the following, with others, submitted by Professor Unwin, Sir Benjamin Baker and Professor Kennedy:

It is very desirable that the mechanical tests to which rails are subjected should be as far as possible standardized in connection with (1) the weight, (2) the section, and (3) the chemical composition of the rail.

After expressing agreement with the conclusions of the sub-committees, the report adds, that as regards chemical composition, the Committee does not think it desirable to insist upon too high a proportion of carbon, manganese or silicon in the steel, having regard to the ordinary contingencies of manufacture, and the greater susceptibility of high-carbon steel to thermal influences.

Appendix VII. (p. 74 of the Report), gives the following chemical specifications for rails, proposed by Mr. E. Windsor Richards, and approved by Mr. E. P. Martin:

	Minimum.	Maximum.		Minimum.	Maximum.
Carbon...	0.35% to	0.50%	Phosphorus	.... to	0.08%
Silicon....	0.05% "	0.10%	Manganese.	0.75% "	1.00%
Sulphur...	0.04% "	0.08%			

(The paper continues with an outline of the work of the International Association for Testing Materials, and particularly of the work of the American Section of this Association, and concludes with a reprint of the proposed standard specifications for steel rails proposed by this section. We reprint only the proposed standard specifications, which are as follows:—Ed.)

PROCESS OF MANUFACTURE.—1.(a) Steel may be made by the Bessemer or open-hearth process. (b) The entire process of manufacture and testing shall be in accordance with the best standard current practice, and special care shall be taken to conform to the following instructions: (c) Ingots shall be kept in a vertical position in pit-heating furnaces. (d) No bled ingots shall be used. (e) Sufficient material shall be discarded from the top of the ingots to insure sound rails.

CHEMICAL PROPERTIES.—2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

Weight, per yd., lbs.	Per cent. of Carbon.	Phosphorus.*	Silicon.*	Manganese.
50 to 59 + ...	0.35—0.45	0.10	0.20	0.70—1.00
60 " 69 + ...	0.38—0.48	0.10	0.20	0.70—1.00
70 " 79 + ...	0.40—0.50	0.10	0.20	0.75—1.05
80 " 89 + ...	0.43—0.53	0.10	0.20	0.80—1.10
90 " 100.....	0.45—0.55	0.10	0.20	0.80—1.10

*Shall not exceed.

PHYSICAL PROPERTIES.—3. Drop Test.—One drop-test shall be made on a piece of rail not more than 6 ft. long, selected from every fifth blow of steel. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests:

Weight of rail, lbs. per yd.	Drop, ft.	Weight of rail, lbs. per yd.	Drop, ft.
45 to and including 55	15	75 to and including 85	18
55 " " 65	16	85 " " 100	19
65 " " 75	17		

If any rail break when subjected to the drop-test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent, will be rejected, but if both of these additional test-pieces meet the requirements, all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop-test as above specified, two other rails will be subjected to the same tests, one from the blow next preceding, and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall also be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests may be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested, if necessary. The acceptance or rejection of all the rails from any blow will depend upon the result of the tests thereof.

4. DROP-TESTING MACHINE.—The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test-rail shall be placed head upwards on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be a part of, or firmly secured to, the anvil.

5. SAMPLE FOR CHEMICAL ANALYSIS.—The manufacturer shall furnish the inspector daily, with carbon determinations of each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test-ingot.

6. SECTION.—Unless otherwise specified, the section of rail shall be the American standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 7, relative to specified weight. A variation in height of 1-64-in. less and 1-32-in. greater than the specified height will be permitted. A perfect fit of the splice-bars, however, shall be maintained at all times.

7. WEIGHT.—The weight of the rails shall be maintained as nearly as possible after complying with paragraph No. 6, to that specified in contract. A variation of ½ of 1% for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

8. LENGTH.—The standard length of rails shall be 30 ft.; 10% of the entire order will be accepted in shorter lengths, varying by even feet down to 24 ft. A variation of ¼-in. in length from that specified will be allowed.

9. DRILLING.—Circular holes for splice-bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs.

10.—FINISH.—Rails shall be straightened while cold, smooth on head, sawed square at ends, and prior to shipment, shall have the burr, occasioned by the saw cutting, removed, and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

11. BRANDING.—The name of the maker, the month and year of manufacture, shall be rolled in raised letters on the side of the web, and the number of the blow shall be stamped on each rail.

12. INSPECTION.—The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

13. NO. 2 RAILS.—Rails that possess any injurious physical defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails, provided, however, that rails which contain any physical defects which seriously impair their strength shall be rejected. The ends of all No. 2 rails shall be painted, in order to distinguish them.

*Abstract of a paper read before the American Institute of Mining Engineers, at the Richmond meeting, February, 1901.

†Philadelphia, Pa.

‡Steel rails: Report of the Committee appointed by the Board of Trade to enquire into the loss of strength in steel rails through use in railways (Parliamentary Blue Book, May, 1900, pp. 7, 8).

DISCUSSION.

P. H. DUDLEY (N. Y. C. & H. R. R. R.), "THE BRITISH SPECIFICATIONS."—Mr. Webster quotes from the report of May, 1900, of the Committee of the British Board of Trade, the following:

The evidence before the committee indicated what the limiting proportions of carbon, sulphur, phosphorus, manganese, and silicon should be. As regards the influence of phosphorus, it is pointed out that, in the broad sense, brittleness of steel does not depend upon the total amount of phosphorus present, as that element may exist in steel in two different forms, one of which is comparatively innocuous.

As regards the limiting proportions of carbon, silicon, phosphorus and manganese, opinions differ, as also do the results obtained in practice. It may be said of carbon (as the committee says of phosphorus) that whether the structure of the metal obtained will be tough or brittle depends upon the form, as well as the quantity, of the carbon in the rails.

With the extensive knowledge now prevalent in regard to the effects of mechanical and heat-treatment upon steel for rails, a range of physical properties can be obtained from the same composition, so that even much higher carbon than those given in the proposed specifications, but with lower phosphorus, will produce a metal of great tenacity. The writer has not had any serious difficulty in obtaining in suitable rail-sections, a tough metal of 55,000 to 60,000 lbs. elastic limit, and 12 to 10% elongation per inch, in the base of the rails, when tested upon the side under the drop.

In regard to phosphorus, the writer has not been so fortunate as to find a part of it "innocuous," in the rail, as a general rule. Rails having 0.08 to 0.10% have broken more frequently in the track than those having only from 0.05 to 0.06%. Our makers may not be able to render the phosphorus "innocuous in one form," and it is to be doubted whether the English practice in that respect is any better; for many English rails have broken in the track under our heavy traffic.

The chemical specifications for proposed English rails are given as though the conditions of traffic were similar to those in the United States. Very few passenger locomotives in England carry as heavy axle-loads as are carried in the United States. The coaches are all smaller; and the majority of them are of the short 4-wheel type, about 32 ft. in length. The wheel-loads are light, and the wear on their rails—which are rolled at a low heat—is similar to that which occurred on our rails with the light wheel-loads of 25 years ago. The volume of traffic is large; but with the light wheel-loads the rate of wear is small.

The weight of the English passenger trains is from 200 to 300 (in a few instances reaching 400) tons, while the mineral and goods trains range only from 300 to 400 (in a few instances 500) tons. Their goods wagons are all small, carrying from 6 to 7 tons, while their coal and mineral wagons carry 10 tons. The coal wagons are not all owned by the railroads, some 500,000 belonging to the private coal companies. They are all small.

The intensities of the wheel pressures per unit area are smaller than those which occur in the United States. The tractive power exerted to draw these light trains is also smaller than is required in the United States for the heavy trains. Finally, the freight rates are two and three times as high as in the United States.

On the Continent of Europe, where the international testing committee originated, the wheel-loads are also light. The weights upon the locomotive drivers are limited, as a rule to 14 tons, while in each locomotive there is a speed indicator, with a tablet, limiting the speed which it can run light or when drawing a train. The speeds are all slower than those necessary for many of the regular trains in the United States.

In this country, containing over 40% of the entire railway mileage of the world, the companies have not made any such limitations as the loads upon the drivers, or the loads upon the car wheels, and we need rails of higher physical properties than are required for the traffic abroad. The locomotive has been doubled in weight and tractive power, and the speed of passenger trains was increased to a marked extent, while the loads drawn by passenger engines have been more than doubled, and those of the freight service have been quadrupled within the past 15 years. This means, of course, more wear upon the rails, tires of driving wheels and all wheels of the rolling stock—a condition which is to be met by higher grades of material. Of the vast quantity of steel put into rails and other railway material, little is used in its best condition. It can all be improved by situable heat-treatment.

THE PROPOSED AMERICAN SPECIFICATIONS.—With regard to the rails manufactured by steel companies under the proposed American specifications, railway companies will wish to know whether or not the rails are guaranteed for a perod of five years against unusual wear or breakage. If the specifications carry a guaranty, then the manufacturers will be responsible for the quality of the product. If, on the other hand, the railway companies must assume all responsibility for the product, then the specifications seem vague as to the physical properties that will be obtained with the best standard current practice and the chemical composition proposed.

It is true that provision is made for a piece of a rail where certain physical properties must stand a specified

drop-test. This would confine the manufacturer to the production of rails that would stand that test, to the exclusion of the consideration of other physical properties which are essential to good rails.

CHEMICAL COMPOSITION.—Unless the current practice should be colder rolling than is now in general use, the proposed composition does not promise any higher physical properties than have been exhibited by rails manufactured of approximately similar composition—though, of course, not exactly, for these specifications are new, and of necessity drawn broadly, to cover a diversity of practice. For instance, the silicon may range from 0 to 0.20.

PHYSICAL PROPERTIES.—The method provided for ascertaining the physical properties of the metal in the rail section, in case one drop-test gives an unfavorable result for five "blows" of steel, is decidedly cumbersome, and not so readily carried out as where the test is made from each blow, to trace the uniformity of the product and guide the manufacture. The heights prescribed for the tup of 2,000 lbs. for the impact tests on sections of different weights are not as suitable for useful tests as those now in current use.

TEST-PIECE AND METHODS OF TESTING.—The provisions that the drop-testing machine shall have a tup of 2,000 lbs. weight, and the striking-face a radius of not more than 5 ins. corresponds to general practice. But placing the rail upon the supports head upwards only tests it for one general property. More information can be obtained by adding to this some tests upon the rails head down, and some upon the sides. In this way the physical properties of the metal are determined to a greater extent than when the test is made only with the head upwards. Placing the supports 3 ft. apart is what the writer considers the best practice. That the anvil block shall weigh 20,000 lbs. is not the usual practice; but it is to be commended. The provisions as to samples for chemical analysis follow the present general usage. It is now customary to make carbon and manganese determinations for each blow, and a complete analysis for each day and night turn, representing the average of the other elements contained in the steel, including copper.

SECTION.—"A variation in height of 1-64-in. less and 1-32-in. greater than the specified height will be permitted." This is in accordance with a very old custom, to allow for the variations in roll-turning. But the variation permitted is larger than should be allowed, because it is too great to produce rails which can be laid in the tracks so that the running surfaces shall be even. The height can be, and should be, practically constant.

WEIGHT.—"A variation of ½ of 1% for the entire order will be allowed. Rails should be accepted and paid for according to actual weights." This is not the custom in the United States. The custom is to confine the weight as closely as possible to that specified for the section; and the rails are accepted practically by length instead of weight, though all payments are made on a tonnage-basis.

LENGTH.—"The standard length of rails shall be 30 ft." This is not the standard of length for rails at the present time. A number of railway companies buy their rails 33 ft. long, and some 60 ft. long. "The variation of ¼-in. in length from that specified will be allowed." This means, in practice, that one rail may be ½-in. longer or shorter than the next rail from the same bar. In relaying rails in the track this necessitates a great deal of adjustment. One-eighth of an inch is all that need be granted in good practice.

CONCLUSIONS.—It would seem quite easy to draw up standard specifications for rails where the conditions of traffic are uniform from year to year. But where the traffic conditions, owing to commercial requirements, are increasing in severity all the time, standards which were ample at one time become unsuitable for a traffic which has doubled or trebled in severity. There is a strong probability that in the future we shall obtain a benefit from mechanical and heat-treatment of the metal during manufacture, like that which occurred to the early rails, or even greater. (The influence was not then noticed.) This will help the chemical composition so that higher physical properties will be obtained for a given composition.

R. TRIMBLE (Pennsylvania Lines West of Pittsburg).—There are in the proposed specifications only two points on which I wish to comment at this time.

Paragraph 6, relating to "Section" reads:

Unless otherwise specified, the section of rail shall be the American standard, recommended by the American Society of Civil Engineers."

I would omit the words "unless otherwise specified," making it read, "The section shall be the American standard," etc. Recent reports indicate a wide use of the American Society sections; and, so far as we are able to judge at the present time, these sections are giving good service, and are satisfactory to all parties. It seems to me that in preparing a standard specification we should adhere, as far as possible, to one standard section. We should make the specification exactly as we want it, and endeavor to convert as many as possible to what we believe to be the best practice. Paragraph 8, relating to "Length," says:

The standard length of rail shall be 30 ft.

To this provision the writer is opposed. Most of us can remember when 28 ft. was the standard length of a rail. This length of 28 ft., and that of 30 ft., which came later, were fixed simply by the length of the cars employed in transporting the rails. But we now have cars from 33 to 38 ft. long (inside dimensions); in my judgment, the shortest car now built for such purposes will accommodate a rail 33 ft. long, and therefore the minimum standard length should not be less than 33 ft. A number of roads are using rails of this length, which has the very great advantage of doing away with 10% of the joints—the joint being one of the weak spots in our present arrangement of track.

E. C. POTTER.—Mr. Hunt's specifications, proposed in 1895, for heavy sections, manufactured west of the Alleghenies (that is, from the ores available in that region), draw the lines a little closer, chemically, as to carbon, phosphorus and silicon than these specifications; but I do not believe they would result in better rails. I think that, in the region supplied with Lake Superior ores, it will soon be, if it be not already, impossible to keep the phosphorus in steel rails below 0.085%—Mr. Hunt's limit—which, I think, may be safely raised to 0.1%—the American Committee's limit. In recent years, I have grown to be a believer in the value of silicon in steel, have seen it demonstrated many times, to my entire satisfaction. I should be willing to see the maximum silicon-limit put higher than that of 0.20%, set by the Committee; and I believe that the change would be beneficial to the rail.

However, I am not disposed to place too much reliance upon chemical composition, or to quarrel seriously with minute differences in limits proposed under that head. I believe that the principal source of the unsatisfactory wear of rails is the treatment of the steel in the rail mill, and that the quality of the future service of a rail may be made or marred right there. The treatment in the heating furnace and the temperature of rolling and of finishing have more to do with the wearing qualities of rails than decimal fractions in chemical composition. But these important factors cannot well be defined in specifications.

GEO. B. WOODWORTH (C., M. & St. P. Ry.)—The specifications of the American Committee seem to be all right. So far as mechanical inspection is concerned, they embody substantially our practice. Two points, however, which are now receiving considerable attention, and the incorporation of which in standard specifications might be considered with advantage, are the increase of the work done in the reduction of blooms to rails, and the lowering of the temperature at which it should be done, especially at the finishing pass. These improvements, I suppose, might encounter considerable opposition from the railmakers, because of their probable effect in limiting the rate of output. In this connection, I may say that during the last three years we have re-rolled and re-laid in the track about 40,000 tons of heavy rails, which had been replaced upon their removal by still heavier sections. The section of the re-rolled rails is about 10% lighter than their original section. We are expecting good results from these re-rolled rails; but it is yet too early to form a conclusive judgment.

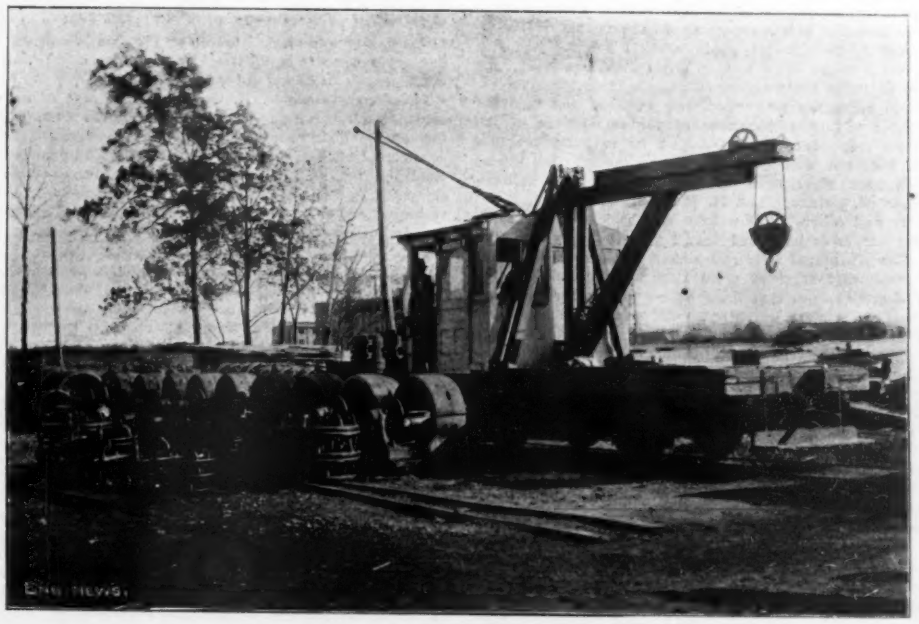
GLASS PAVING BLOCKS are being experimented with in Paris by laying a test pavement on the Rue du Havre. The blocks are pure glass, subjected to a process of "devitrification," with the result that the material obtained is hard, smooth, opaque and non-porous, with remarkable resistance. It is not effected by heat or cold, and the inventors claim that it combines the solidity of granite with the smoothness of asphalt. But it is expensive, costing $1.50 to $2 per sq. yd., and it is extremely noisy.

AN ELECTRIC LOCOMOTIVE AND CRANE.

In the handling of materials in the yards and buildings of large factories and other industrial establishments, locomotive cranes are exceedingly useful tools. Steam locomotive cranes have long been in extensive use, and their merits are pretty well known; but equally good results are attained by electric locomotive cranes, and they have the added advantage of eliminating the danger of fire and of avoiding the nuisance of discharging smoke, steam and hot gases, which may sometimes injure the paint or finish of goods ready for shipment. On this account, too, the electric locomotive crane can be used inside buildings.

In both steam and electric locomotive cranes as generally constructed, the machine has been self-propelling, but has not been designed for heavy traction. In the machine herewith illustrated, however, the functions of an electric locomotive crane and an electric locomotive are combined, and the machine is capable of heavy and continuous work in either capacity.

The machinery is mounted on a four-wheeled flat car, with heavy cast-iron side frames to give the necessary weight for adhesion, and to serve as a counterbalance in hoisting. Near the middle of the car is a pivoted derrick, or crane, of substantial construction, with steel post, boom and brace, and timber A-frame and back brace, reinforced by heavy tie rods. Behind the crane is the operating cabin, while the space in front may be utilized for materials to be transported.



AN ELECTRIC LOCOMOTIVE AND CRANE.
Bullock Electric Mfg. Co., Cincinnati, O., Builders.

The car is 22 ft. long and 9 ft. 6 ins. wide over all, with a height of 13 ft. 6 ins. from the rail to the top of the crane, and its capacity is rated at 40,000 lbs. It has four 33-in. cast-iron wheels, and the wheelbase is only 9 ft.; so that the car can readily pass around very sharp curves. An electric motor is fitted to each axle. The floor space available in front of the crane post is 14 ft. long. The crane has a capacity of 5 tons with a 10-ft. radius, but the top arm of the crane is extensible, so that the radius can be varied as required. The hoisting and swinging movements of the crane and the motion of the machine along the track are all controlled from the cabin, which contains the three controllers, a brake, a main switch from the trolleys, main line fuse block, and the crane gearing.

Direct current is used, which is available in most modern plants, and by the use of the double overhead trolley system the necessity of connecting to the rails as a ground is avoided. The machine can handle eight loaded freight cars on the level, or two cars on a 2% grade. It is one of the specialties of the Bullock Electric Mfg. Co., of Cincinnati, O., and our illustration is reproduced from a photograph of a machine in use at that company's works.

FINISHING TEMPERATURES FOR STEEL RAILS.

By Robert W. Hunt.†

In 1887, Mr. William Metcalf, in his paper presented to the American Society of Civil Engineers, on "Steel: Its Properties; Its Use in Structures and Heavy Guns,"‡ gave an exhaustive and lucid treatise on the effects of heat and work on steel. This paper has become classical. Sitting at the feet of such a master, I have endeavored to emphasize the prime importance, in their relation to steel rail making, of the principles so clearly stated by him. In a paper on "Specifications for Steel Rails,"§ read at the Buffalo meeting of the Institute in October, 1888, I sought to prove the importance in relation to the wear of rails of their section and the physical treatment of the steel during their manufacture. Later, in February, 1889, in a paper on "Proposed Rail Sections,"** I again urged the same points.

The tremendous increase in the tonnage of railway traffic and the weight of the rolling stock employed in it having made the use of heavier sectioned rails imperative and practically universal, and a wonderful development of the iron ores in the Northwest having taken place, I was led to present to the Institute, in October, 1895, another paper, entitled "Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghanies,"*** in which I urged again the paramount importance of work applied at reduced temperatures. It was my privilege to bring this point to the direct personal attention of many railway engineers at the first annual convention of the American Railway Engineering and Maintenance of Way Association, March 15, 1900.‖

I urged this in the discussions of the American Society of Civil Engineers during the deliberations which resulted in the adoption of the report of its Committee on Standard Rail Sections,‡‡ and, again, when I had the honor of presenting to the same society, at its London meeting, my paper on "The Manufacture of Rails in America."§§

While venturing to particularize some of the recorded instances of my elaborations of the importance of the physical treatment of steel during its manufacture into rails, I do not wish to imply for an instant that others have not also maintained the same position. D. J. Whittemore, F. C. Delano, Thos. H. Johnson, Wm. Sweet, P. H. Dudley and others have written and spoken to the same effect; but as it happened that I was the only one who had been an actual steel rail maker, it came to pass that my statements received more attention than they probably deserved; and that must be my excuse for referring to them. But mere words never did accomplish anything, and no matter how much or how often any of us wrote and spoke, so long as the railmakers did not act, unsatisfactory rails continued to be furnished to the railroads.

As the rush of the modern mill and its tremendous productions seemed to preclude the possibility of obtaining rails rolled at lower heats, I advocated trying to obtain from chemical composition that which could not be secured, under the circumstances, from physical treatment; and hence I advocated harder steel in proportion to the increase of section. In fact, good results have come from such mixtures; but I have always insisted, and do now insist, that the chemical composition is secondary to the physical treatment of the metal. There have been instances in the experience of many railway engineers where they have obtained excellent service from steel rails made in the earlier days whose chemical analysis revealed the fact that they had neither good nor even consistent chemical character. They were high in carbon and low in carbon; high in manganese and low in that element; high in phosphorus and higher in phosphorus, and so on. But they all yielded good service.

Early in 1895 the Pioneer Rail Renewing Co. was organized to develop and operate the process of renewing steel rails which had been invented and patented by E. W. McKenna. He had been, during his whole business life, an operating railroad man, and as such had been impressed by both the tremendous expense attached to the rail part of maintenance of way and the comparatively short service obtained from the majority of rails—not always because they broke or wore out, but because they became so rough that they were unfit for main-track use; or their ends became battered and had to be cut off. This latter procedure was expensive; and when the rails were put back into service they did not give a good track, both on account of the increased number of joints and because of the mismating of the rails. So long as the roads had branch lines or sidings laid with iron rails, the rails from the main track could be used to replace the iron ones, for which there was a constant market; but he foresaw that as the sections on the main line increased in weight, and the subsidiary lines were laid with steel heavy enough and good enough for their requirements, the railway companies would be left without a market for the heavy-sectioned worn-out rails. These considerations led to his scheme for renewing rails and restoring them to their original service in main-line tracks.

The Pioneer Co. rented the old North Chicago rail mill of the Illinois Steel Co.—the mill, by the way, in which the first steel rails rolled in America were made. Here rails were renewed on experimental orders from several different roads. It required time to demonstrate by service the success or failure of these rails.

From the first, I had maintained that the renewed rail would wear better than a new one—basing my belief upon its receiving more work, and that at a low temperature. The rails gave such good results that more capital was raised, and the McKenna Steel-Working Co. was organized, which built a new rolling mill at Joliet, Ill. This was followed by another at Kansas City, Mo.; and I believe one is soon to be erected in the vicinity of New York.

Thousands of tons of rails have been renewed and are giving satisfactory service; and I believe the success of the McKenna renewed rail has had more to do with the commercial recognition of the heat-and-work principle than all of our talks and writings. It was an actual demonstration on a scale which could not be ignored.

The officials of great railway companies were restive in their dealings with the railmakers. Commercial conditions became such that there could not be any question that the rail business yielded profits; therefore, buyers felt free to demand better goods.

Several of the rail-making companies—notably the Illinois Steel Co. and the Carnegie Steel Co.—recognized the inevitable, and prepared plans for the alteration of their rail mills. The latter has carried its plans into execution, and is to-day rolling rails in its modified mill. All is working well; and I have no doubt as to the better quality of their rails so manufactured. I believe the Cambria Steel Co. has taken steps to equip itself on the same lines; and no doubt others will soon do so.

The Pennsylvania R. R. Co. made it a part of its rail contracts for this year that the rails must be finished at a low heat. This naturally brought up the question what constituted such a heat, and how it should be determined. Representing, as I do, the Pennsylvania Lines West of Pittsburg in their rail inspection, I was consulted; and I recommended the use of Lunette pyrometers. This led to a series of heat-observations with such an instrument, the results of which I shall give.

It may be that the Ducretet & Lejune pyrometer does not give the exact heat-degrees, but from my observations I feel certain that it does yield consistent results. If it does that, it will be all that is required. Mr. Thomas Morrison, General Superintendent of the Carnegie Steel Co.'s Edgar Thomson Works, who planned and executed their mill alterations, thinks that the distance between the hot saws, which is found to yield a rail of desired length, will be a sufficiently accurate and practical controlling factor as to the heat at which the rail is finished, and I concur with him; but I think also that the Lunette pyrometer will assist, and will always give quick results.

As observed by such an instrument, the heat at which rails of 80 lbs. to the yard were furnished under old conditions in most rail mills averaged 1,795° F. In the Edgar Thomson mill, under existing conditions, the following observations were made, and have been followed by many others, on 80-lb. American Society section rails, and also on the lighter sections, with similar results:

Temperature of partially formed rails when first placed on cooling table: 1,742°, 1,772°, 1,772°, 1,742°, 1,772°, 1,772°; average, 1,762° F.

Temperature of finished rails on leaving the rolls: 1,600°, 1,600°, 1,574°, 1,574°, 1,574°, 1,574°, 1,574°, 1,600°; average, 1,580° F.

The rails remained on the cooling table about 1 min. 12 secs.; the longest time observed being 1 min. 20 secs., and the shortest 1 min. 6 secs.

It was found that the saws, to yield an 80-lb. rail 30 ft. long when cold, had to be set quite 1 in. nearer together than under the old practice.

In the Joliet McKenna renewing mill, I found that the average temperature at which the rails were drawn from the reheating furnaces was 1,750° F. As the rails left the finishing rolls their average temperature was 1,480° F. It will be noticed that this was lower than the Edgar Thomson average; and I believe, as the difficulties which surround all new manufacturing steps are overcome, the latter works will finish a little cooler. But this can be overdone. If the steel is too cold it will spring the rolls, receive no work on its interior structure, and so be unsatisfactory. While this can be easily understood, theoretically, Mr. Morrison has demonstrated it by actual work.

Messrs. Morrison and Julian Kennedy have united in a patent for the handling of the rails while on the intermediate or cooling bed, the gist of which covers the placing of the head of one rail against the flange of another, and so on. The head of the outside rail to be first entered in the finishing pass is exposed; but the bottom of its flange is against the head of the next rail. The theory is that, the flange being thinner, its heat will pass off more quickly; that it will thus draw heat from the head of the rail lying against it, and so will remain longer at a temperature sufficiently hot to roll; and that it will thus give more time for the heat to pass off from the head of the rail, which, as stated, lies exposed. When that rail is entered in the finishing rolls, of course the head of the next one which had been against its flange, becomes exposed, and so on.

I am happy to say the new method of rolling at the Edgar Thomson Mill does not interefere with its large product. In other words, the production is now quite as large as before its introduction; but the wear of the finishing rolls is greater, and it must be harder on the hot saws.

The rails are finished free from scale, and the steel shows more elasticity under the cold-straightening press. The fracture of the rails is much closer—that is, the grain of the steel is much finer than in rails of the same section rolled under the old practice. Such metal must offer greater resistance to abrasion.

There are two rail mills at the Edgar Thomson works; in the older one, rails of light sections are rolled. At the time of my observations of the finishing temperatures of the 80-lb. rails, 40-lb. ones were being made on the old mill. The blooms for these were taken indiscriminately from the heats of steel which went into the 80-lb. rails. It was found that the average finishing temperature of the 40-lb. rails was 1,780° F. As the size of the original blooms for both rails was the same, it follows that the light sections received the greater amount of work, but, as stated, the last, or finishing work, was performed at a higher temperature. I had rails of both sections nicked and broken, and found the grain of the 80-lb. rail to be finer than that of the 40-lb. one. This, to me, is a convincing demonstration of the effect of work applied at low temperatures.

It is with great hesitation that I venture to suggest new rail sections; and perhaps the very fact of my having been not only a member, but the secretary of the Committee of the American Society of Civil Engineers on "Standard Rail Sections," whose labors resulted in the recommendation by that Society of what are now the practically recognized American standards,* ought to make me hesitate all the more; but, on the contrary, I think the knowledge gained in that position gives me the necessary courage to re-open the question.

I regard the described rail-rolling practice as a revolution in steel-rail making. As such, it justifies that which would have been unnecessary under other conditions. Now that the makers have modified their rolling practice, it is but wise for the railway engineers to modify their rail sections, so as to obtain the best results from such practice, and in doing this, at the same time adopt sections which will be the best for renewing, while adhering to all of the essential features of the sections recommended by the American Society's committee.

Some railway officials may not be prepared to admit that renewing is to be considered, but I venture the assertion that when the time comes for the necessary removal of the heavy section from tracks, renewing of them will force itself upon their favorable consideration. At all events, if we should adopt a section which (1) is the best for the original manufacturer of the rail; (2) will give satisfactory results in service; and (3) is good for renewal, it would seem that we had acted wisely.

The American Society sections, as they are commercially designated, have made their way until they are practically the standard ones of the country. All roads do not use them; but the majority do. Therefore, they should be regarded as the basis on which new sections are to be designed. I would not advocate changing the 80-lb. section, or those below it, but I do think, in view of the coming manufacturing conditions, that the heavier sections can be advantageously altered.

The greater the area of metal in the head of a rail, the longer it will take, while lying on the intermediate table, for the heat to pass off; if sufficient time is not given, the less will be the "fining," effect of the finishing pass; and the length of time which the rail can remain on the table depends on the temperature of the flange. The thinner it is, the more rapidly will it cool, and hence, as stated, its condition controls.

Therefore, I think it will be well to design new sections for 85, 90, 95 and 100-lb. rails on lines adapted to this heat-condition, and which will also be best for renewal into lighter sections.

In American railway practice, rails are not permitted to remain in main lines until the wear of metal from off the top of their heads has exceeded ¼-in. Side or curve wear is another matter. Logging roads, and other usual customers for relaying rails, cannot afford to buy them of such heavy sections. It certainly will not be economy to consign them to the scrap heap. Renewing them certainly will be true economy; and it can be confidently expected that the rails will be improved by each renewal. I believe that the existing Committee No. 4, on rails, of the Railway Engineering and Maintenance of Way Association, is the proper body to prepare the sections, and hope they will do so.

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*Abstract of a paper read before the American Institute of Mining Engineers at the Richmond meeting, February, 1901.

†Chicago, Ill.

‡Trans. Am. Soc. C. E., vol. xvi., p. 283.

§Trans., xvii., 226.

**Trans., xvii., 778.

***Trans., xxv., 653.

‖Proceedings of the Convention, p. 121.

‡‡Trans. Am. Soc. of C. E., vol. xxviii., p. 425.

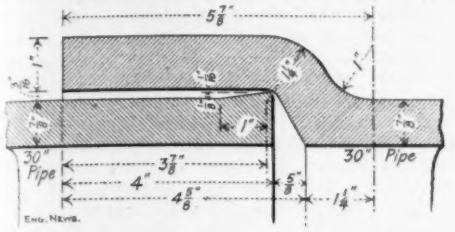
§§Proc. Am. Soc. of C. E., vol. xxvi., p. 752.

THE STRICKLER TUNNEL litigation between the city of Colorado Springs, Colo., and the sureties for the contractors, has been finally closed by the city agreeing to pay $16,690 to the contractor. The controversy has been a long one, and the court decision in favor of the contractors was given in our issue of Nov. 22, 1900.

*Trans. Am Soc. of C. E., Vol. XXVIII., p. 425.

CAST-IRON CULVERT PIPE; CHICAGO & NORTHWESTERN RY.

The accompanying cut shows the form of spigot and bell adopted for cast-iron culvert pipe by the Chicago & Northwestern Ry., the pipe being made in lengths of 6 and 12 ft. In most cases the ordinary form of bell, as used on water and gas pipe, is employed for culvert pipe, but in this case the form more closely resembles that of clay culvert pipe, there being no flange, and the maximum



Joint for Cast-Iron Culvert Pipe; Chicago & Northwestern Ry.

clearance being only 3-16-in. between bell and spigot. This form is used for the purpose of preventing earth and other filling from getting into the pipe and obstructing the waterway, and as no calking is done the bell is made very thin. When accessible the joint is filled with cement. We are indebted to Mr. E. C. Carter, M. Am. Soc. C. E., Chief Engineer of the Chicago & Northwestern Ry., for the blue-print section herewith reproduced.

TRACK CIRCUITS IN RAILWAY SIGNALING PLANTS.*

By A. G. Shaver.†

Nearly all modern installations of automatic signals, and especially block signals, are made with track circuits as the medium through which the indication is given, and it is the opinion of the writer that in new installations too little regard is given to this really very important feature of the work.

In making his plans the engineer is too apt to confine himself too closely to a map of the tracks, and not take into consideration, as he should, the kinds of ballast and the actual condition of the ties and rails. As a rule, none of the common kinds of ballast give any trouble in dry weather, but in wet weather there is more or less leakage of current from one rail to the other with all of them. Dirt comes first as the poorest ballast of all, and next in order, so far as electrical conductive properties are concerned, come cinders, burnt clay, gravel and crushed stone. Where dirt is the only kind of ballast in a track, it is usually necessary to make the track circuits short, but with stone of a good quality, it is possible to make them of mile lengths, when using the proper sort of relays, without any serious trouble being caused by leakage, unless, of course, there are a large number of switches in the circuit.

No matter how carefully a switch is insulated and wired around, there is liable to be more or less resistance and leakage in the circuit there, but, using the ordinary gravity track battery in the circuit, there should never be a drop in voltage greater than one-tenth.

Ordinary dry cedar and oak ties are better insulators under rails than ties treated by the chloride of zinc and tannin process. These latter seem to cause a leakage about 5% greater than with the former.

As oxide of iron is a good insulator, there will be less leakage of current, due to contact with the ballast, in a circuit where there are old rails than where the rails are new. Perfection has not yet been reached in the manufacture of insulating joints. So far as insulation goes, the old wooden type of joint is probably as good as any.

The common commercial kinds of fiber do not stand moisture as they ought, and the resistance of a joint containing fiber will drop from the neighborhood of 1,000 ohms, when first put in, to an average of 8 to 10 ohms after having been in use and exposed to the weather for a time. Insulation of this sort seems to be penetrated and disintegrated by moisture and does not appear ever to dry out, even in the dryest kind of weather.

For track circuit work an insulation is needed which is impervious to water and has a tensile and compressive strength as nearly as possible equal to that of iron itself. It has been the writer's experience that 90% of the signal failures in automatic electric signaling have been due to the track equipment, and a goodly portion of them have been the fault of the insulation.

Again considering the length of the track circuit, the resistance from rail to rail should never in any case be less than that of the relay in that circuit, and as this resistance decreases directly in proportion to the length of track in circuit, it would seem to be necessary, in increasing this length, to decrease the resistance of the relay in the same proportion in order to get the same amount of current through the coils. Now a certain magneto-motive-force is required to operate the armature of a relay, and as this is directly dependent upon the number of ampere-turns in the coils, it would be necessary in order to keep this quantity constant in decreasing the resistance of the windings, to change the quantity of iron in the cores and to increase the size of the wire used.

But all this is troublesome, and cannot well be carried out in practice. The custom universally appears to be to make use of a relay of practicable size and adopt it, if possible, to track circuits of convenient length. The smallest practicable unit of electrical energy, the gravity battery, is in use in track circuits almost everywhere, but the biggest portion of its output is not utilized in the relay, and the question which presents itself in this connection to the writer is, cannot some of this wasted energy be made use of and better results be obtained by proper care being taken in installing the track circuits and in determining upon a form of a relay having such a relation between magnet cores and core windings, that its range of usefulness will be larger than with those at present in the market?

*A paper read before the Railway Signaling Club, at Chicago, May 14.

†Assistant Engineer, Union Pacific Ry.

BOOK REVIEWS.

THE DIRECTORY OF DIRECTORS IN THE CITY OF NEW YORK, for 1901. New York: The Audit Co., of New York, 43 Cedar St. Cloth; 5 × 8 ins.; pp. 844. $3.

The present issue of this very handy publication is much enlarged over the last edition, the appendix being especially extended. The appendix contains the names of the principal corporations, with the officers, and is convenient as a cross reference. The main part of the book contains a list of about 20,000 names of persons, arranged in alphabetical order, in each case followed by the names of the companies in which the person mentioned is a director.

RAILWAY TRACK AND TRACK WORK.—By E. E. Russel, Tratman, Assoc. M. Am. Soc. C. E., Associate Editor of Engineering News. Second edition; Fully Revised, and with Supplementary Chapters on "Signals and Interlocking" and "Street Railway Track." New York: Engineering News Publishing Co. Cloth; 8vo.; pp. 471; illustrations, 226; folding tables of standard track construction on 54 railways. Price, $3.

As this book is one of our own publications, we follow our usual practice in simply giving some extracts from the preface, which sufficiently explain the scope and character of the work.

The continued demand for this book, not only from engineers but from the engineering schools, many of which have adopted it as a text book, has now been met by the preparation of this second edition, which has been entirely set up in new type and almost entirely rewritten. Since 1897, many changes and improvements have been made in materials and methods, while new standards have been adopted with the general progress made in this department, and these various improvements are represented in the revision. Not only has the book been thoroughly revised, but many new illustrations have been made, and additional chapters have been added dealing with signals and interlocking and street railway track. As to the latter, it may be noted that street and country electric railways now offer such a wide and new field for engineers, that it was felt the book would not be complete without some mention of this branch of the subject. The tables of standard track construction are also entirely new.

A special feature of the book is that it includes not only the general principles underlying track work, and the systems of practice which are everywhere applicable, but also includes numerous individual details of material, appliances and work, and methods of practice, which vary on different railways and in different sections of the country. It is believed that mere general statements as to methods of work and construction leave very much to be desired both by the beginner or student and by the engineer in charge of maintenance of way work. It has been the author's special aim, therefore, to present drawings and details of materials and methods, representing varied and actual practice, and to show their good and bad features, as well as the reasons for their use. This particular characteristic of the style of treatment adopted has met with very considerable commendation, showing that it meets a definite need. The scope of the book is large, and the various subjects included are treated not merely in a descriptive but also in a critical manner.

A MANUAL OF FIELD AND OFFICE METHODS FOR THE USE OF STUDENTS IN SURVEYING.—By William D. Pence, Professor of Civil Engineering at Purdue University (Lafayette, Ind.), and Milo S. Ketchum, Assistant Professor of Civil Engineering at the University of Illinois (Champaign, Ill.) Cloth, with flap cover; 4½ × 6¾ ins.; pp. 232; illustrated. Price, $2.00.

This attractive looking and very compact text-book was prepared for the use of the beginning classes, and is not intended to replace (but rather to supplement) the more elaborate treatises on surveying which are generally used in engineering schools. It has, however, been found sufficient for an elementary course, and has been so satisfactory that the authors decided to publish it for use outside of their respective institutions. It is designed to bring the student into immediate familiarity with approved methods, and to cultivate his skill in the important arts of keeping good field notes and making reliable calculations, arts in which even experienced men are often notably weak.

After a chapter of practical instructions regarding field work (instruments and notes), the use of the chain and tape is described, and this is followed by chapters on the compass, the level and the transit, describing the use and testing of these instruments in various classes of work. Other chapters are devoted to topographical, land and railway surveying, describing in detail the organization and work of field parties, the office work, preparation of profiles and estimates, cross-section work, curve problems, etc. There are also chapters on errors of surveying and methods of computing. Practical problems, with descriptions of the methods of solving or performing them, are interspersed throughout the book. The closing chapter, on freehand lettering, deals with the Engineering News style of lettering, which has been used by the authors for field notes for some years.

The book is well and clearly printed and is so thin that it can readily be carried in the pocket, while the flap cover serves as a marker. One criticism which may be made is in regard to some of the pages and some examples of note-books which are reproduced from originals lettered by hand, the reduction being rather too small for convenient use, even for young eyes. Lettering of this kind is not as easy to follow as printed type for continuous reading, and its use is a little trying. Its use is certainly allowable as showing the neat appearance of note-books kept in this way, although the examples might well be somewhat larger, but for general reading it would have been better to have had the matter set up in type. The book is well arranged and is written in a clear, concise manner, which should make its study easy and pleasant.

PUBLIC WATER SUPPLIES.—Requirements, Resources and the Construction of Works. By F. E. Turneaure, C. E., Professor of Bridge and Sanitary Engineering, and H. L. Russell, Ph. D., Professor of Bacteriology, University of Wisconsin. With a chapter on Pumping Machinery by D. W. Mead, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 746; 231 illustrations and 101 tables. $5.

Few technical books aiming to give a comprehensive review of a large subject are so satisfactory as is this volume. One puts down the book with the feeling that at last a treatise is available which bids fair to serve the needs of the present day as satisfactorily as the requirements of thirty years ago were met by the first edition of Mr. Fanning's notable work on water supply engineering. It would be difficult to say which author had the most difficult task. Mr. Fanning's book probably contains much more original matter and was prepared at a time when there was comparatively little to guide one at many points, but the authors of the present volume, while doing less original work, may be said to have suffered from the abundance of the material awaiting correlation, digestion and the drawing of conclusions. It would be hard to find a better illustration than is afforded by this book of the fact that one must go to the society proceedings and to the engineering journals to post themselves on the theory and practice, particularly the practice, of engineering at the present day. The foot-notes and the excellent bibliography at the close of each chapter, as well as a large percentage of the illustrations, emphasize the force of the statement just made. The authors themselves, in their preface, say that in their opinion

there is no branch of the profession in which a good working library, consisting largely of periodicals, is more necessary than in that of municipal or sanitary engineering.

The general plan of the book will be made apparent by stating that Part I. treats of "Requirements and Resources," and is divided into sections on quantity of water needed, sources of supply, and quality; and that Part II., on "The Construction of Water-Works," includes sections on works for collection, purification and distribution. The various subdivisions are well chosen, but too numerous to give here.

As to the division of authorship, Professor Russell wrote the whole section on the "Quality of Water Supplies" and several of the articles in the five chapters on "Works for the Purification of Water." Mr. Mead wrote the excellent chapter on "Pumping Machinery." The literature of the flow of water in pipes was investigated by Mr. C. B. Stewart, Assoc. M. Am. Soc. C. E., who prepared a diagram for calculating cast-iron pipes. This diagram was published in Engineering News for April 11, 1901, together with some explanatory matter by Mr. Stewart, not included in the volume under review. The balance of the book was written by Professor Turneaure.

Where so wide a range of information is presented at such length, there is ample room for differences of opinion at some points. For instance, it is very likely that many engineers will disagree with the recommendation of the use of Flamant's logarithmic formula for the design of cast-iron pipe distribution systems (see Eng. News, April 11). Perhaps it would have been better to include one or two diagrams based on some of the other formulas, including Kutter's; but not every one is wedded to Kutter's formula, and for those who are plenty of diagrams are already available. Assuming that the foregoing will suffice for possible errors of commission, it may be said as to errors of omission that we have noted few of moment, considering the scope of the book and the fact that the authors did not stop until, including illustrations and index, they had filled about 750 good-sized pages. Those who wish more detailed information on dams, hydraulics, pumping machinery and water purification need not be at a loss, as in earlier days, to know where to turn to find it, in view of the excellent books devoted to these special subjects which are now available.

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ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

We commend to the attention of city engineers, as well as all others interested in municipal improvements, the paper in this issue on "Parking Wide City Streets." We know of no movement in recent years more beneficial to city taxpayers and property-owners than that for limiting the width of the pavement on residence streets to what the traffic really demands, and throwing the rest of the street's width into grass plots. The improvement in appearance of the streets so treated is wonderful. Especially in our hot summers, the contrast between a broad expanse of glaring dust, reflecting heat to the houses on either side, and the same street with its unused width converted into cool green lawn space, is something that deeply impresses every one who has seen it.

It may be pointed out here, too, how greatly such a change simplifies very many problems of city administration. The narrower pavement costs less to keep in repair and much less to keep clean. Its first cost is so much less that the paving of streets can be carried forward much more rapidly than would otherwise be possible. The lawn strips between the sidewalk and the street (or at the center of the street, where that plan is adopted), can be utilized for the laying of sewer, water and gas pipes, which can then be reached without breaking any pavement; and wires can be placed underground in such locations where laying them under the street surface would be prohibitory in cost.

Such a change in effect makes every residence street a park and reduces the necessity for municipal expenditures on other parks. It would take a bold guesser to estimate the millions of dollars that have been spent in the United States to pave street space that is not used for traffic, and which would be vastly more beneficial to those who live beside it if covered with grass and trees.

The meeting of the National Municipal League, reported elsewhere in this issue, was decidedly encouraging to those in attendance. The report by Dr. Thomas M. Drown showed that a fair number of American colleges are giving instruction in municipal government. The two half days devoted to uniform municipal accounting gave evidence of both interest and progress in what many people consider to be the keynote of municipal reform. Reports made to the conference showed that a number of schedules looking to greater uniformity in municipal accounts and statistics have been completed, while others are now being drawn. A common schedule for a summary of water-works statistics, in place of the three drawn up by as many organizations, was considered to be most desirable. It was felt that the co-operation necessary to bring this about might be secured with comparatively few compromises and concessions on the part of the societies chiefly concerned. We trust that this may prove to be the case.

There appears to be a current idea in the United States that enormous profits are made by those who carry on the business of ocean transportation. That idea appears to be confirmed when America's "Napoleon of Finance" purchases the Leyland line at a price so high that its British owners are glad to sell out the business. Perhaps Mr. Morgan, or his representatives, can carry on the shipping business in such a manner as to make larger earnings and lower expenses than the British owners have done. Unless they can do this the motive for the purchase of the Leyland fleet must remain a mystery. The facts are that the ocean shipping business is pre-eminently one in which profits and losses fluctuate greatly from year to year. In the early '90's there were years when many thousand tons of shipping was idle because of lack of business, and the vessels which ran brought little or no profit to the owners. The revival in industry from 1897 to the present time, coupled with the Spanish-American and Boer wars, has made the shipping industry more active than for many years. In Europe, however, the tide has now turned. "Fairplay," a well-known organ of the English shipping trade, declares that "the shipping industry is losing money hand over fist." Under these circumstances, it is small wonder that the British owners of the Leyland line were ready to part with it at a price based upon the abnormally high earnings of the past two years.

A great hue and cry was made in this country last year over the prospects of an export trade in American coal. It is true that if the abnormally high prices of last year were to be permanent, it would be possible to export American coal to some ports—those in the Mediterranean, for example, at a small profit. Now that prices have returned to their ordinary plane, however, the cost of transatlantic carriage is an effectual barrier to the sending of our coal to Europe. The time may come, when British and European coal deposits approach more nearly to the day of their final exhaustion, and costs of mining increase, that large quantities of American coal will go across the Atlantic; but present commercial conditions give no hint of such a time.

Apropos of our remarks last week concerning the trifling benefit which a nation gains from the export of raw materials as compared with the export of manufactured goods, it is of interest to learn that the Russian Minister of Finance is said to contemplate levying a duty on the export of rough lumber. It may also be noted that the opposition to the English export tax on coal has practically disappeared. The convention of miners called to consider the advisability of a universal strike as a protest against the duty, adopted resolutions abandoning their opposition because of the assurances of the Government officials that the tax would in the end fall on the foreign buyer of coal.

CONCERNING NORTH RIVER BRIDGES AND TUNNELS.

The conditions which confront the projectors of bridges or tunnels across the North River at New York city were briefly set forth editorially in our issue of May 2. On another page of the present issue we print a recent paper and discussion before the New York Railroad Club, in which views similar to those we have expressed were brought forward by prominent engineers.

It is not at all strange that the general public and the great majority of engineers in other parts of the country who know nothing of the local conditions suppose the Hudson River to be a great barrier to the traffic to and from Manhattan Island. Anyone who forms opinions on general principles only is pretty sure to be led into numerous errors; the common idea of engineers who know nothing of New York that its commerce suffers for lack of a bridge to accommodate the railways leading westward is a notable illustration of this.

As was plainly brought out in the New York Railroad Club discussion, one class of traffic and one only could use a North River bridge with profit, and that is the hurrying thousands of suburban dwellers who stream toward the city from a hundred New Jersey towns and cities every morning and return every night. With the majority of these travelers, it takes longer to go from the city office to the ferry and thence across the river to the train waiting on the western side, a distance of perhaps a mile and a quarter, than it does to travel all the rest of the way home, perhaps 8 to 15 miles. Not all of this is to be charged to the ferry of course. The average Jersey commuter spends about an hour in traveling from his home to his office. A quarter of this time represents the walk to the ferry and another fifteen minutes is the time taken in crossing the river and passing to the train on the other side.

The problem before an engineer is how to so plan bridges and terminals in New York as to save part of this half hour for the commuter. If the bridge cannot effect a considerable saving here, it is difficult to see how it can attract suburban traffic. The commuter had as lief cross the river by a ferry as by a bridge. He will only choose the latter if time is to be saved by it.

To the man unfamiliar with local conditions this again may seem strange. But the fact must be remembered that the North River passenger ferries have been developed to a degree of excellence and comfort unequaled anywhere in the world. To the commuter who can step into his train on the New York side and go without change to his home station in New Jersey, the bridge will be a more attractive route; but nine-tenths of the suburbanites must take a car or train in New York to reach the proposed bridge terminal station, so the choice is merely between the street car in New York or the ferry across the river. Of the two, the ferry is vastly the more comfortable. If this is understood, the reader can appreciate why the bridge route must save its passengers time if it is to attract their patronage.

Again, upon this matter of time saving the location of the bridge largely hinges. The 59th St. location of the New York and New Jersey Bridge Co, puts that project out of the range of practical possibility as a suburban passenger route as effectually as if it were located at Tarrytown. Even the 23d St. location, which the North River Bridge Co. has selected, has always seemed to us too far uptown to attract the largest traffic. On the other hand, it is certainly true that the proportion of uptown travel by the ferries is slowly but steadily increasing. A new "office building district" is growing up around Madison Square. When a bridge is completed across the river, with its terminal near this point, it will be a further stimulus to the growth of this section, and there will be a tendency for those whose business centers in this location to find homes in New Jersey, rather than in the region beyond the Harlem.

Turning to the present situation of the various bridge and tunnel schemes: The New York and New Jersey project, if it had any real vitality, has now received a probable death-blow through the veto by Gov. Odell, on May 11, of its franchise for a West St. elevated railway, granted by the recent New York legislature. The North

River Bridge Co., as announced in this journal two weeks ago, has secured the backing of the Pennsylvania and other railway companies, and expects to begin work on its bridge in about a year and a half. The Hudson River tunnel scheme is showing faint signs of life, although its condition, both financially and as an engineering scheme, must discourage the most ardent of its friends. As pointed out by Mr. Buchholz, in his New York Railway Club paper, locomotives could not operate such a tunnel, two miles or more in length with its approaches, and the commuter taking this route would therefore have to take a street car to the tunnel terminus, then a train through the tunnel and then a steam train for his final destination. That such a route could compete with the present system of ferry transport is beyond belief. Let those who favor transport through a deep subaqueous tunnel ride through the City & Southwark subway, under the Thames, and inhale the foul odors which are encountered there. Deep tunnel transit for passenger traffic has its difficulties, and electric motive power has by no means solved them all.

From present appearances, therefore, the North River Bridge Co. appears to be by far the most likely to solve the problem of passing the North River. The design of this bridge, made by the President and Chief Engineer of the Company, Mr. Gustave Lindenthal, was illustrated in Engineering News in January, 1888, and is a suspension structure, with a single span of 2,850 ft., far exceeding in size any other bridge ever erected. An idea of the difficulties which beset the builder of bridges or tunnels to Manhattan Island may be gained from Mr. Lindenthal's recent statement that great as will be the cost of the bridge, the right of way and terminals for its approaches will cost three times as much as the bridge itself. This, be it remembered, is for passenger service only. Viewed in this light, the absurdity of the proposition to build freight terminals for either bridges or tunnels on Manhattan Island, of which so much has been heard recently, can be better understood.

THE DANGERS OF THE ST. LAWRENCE ROUTE FOR EXPORT TRAFFIC.

For many years it has been assumed with little question that the St. Lawrence route was the cheapest for export traffic from the grain-raising Northwest to Europe, and that a great volume of traffic would be diverted from American ports to that route as soon as Canadian waterways of sufficient depth were provided. It is belief in this that has led to the promotion of schemes for a ship canal from Lake Huron via the Ottawa River, and it has induced the deepening of the St. Lawrence canals until a depth of 14 ft. has been attained. The coming competition of the Canadian route, indeed, has been for years a bugbear to New York. It has been one of the chief arguments or those who have favored the enlargement of the Erie Canal, and has been set forth as a menace to New York by the various high authorities who have reported upon the alleged decline of New York's commerce, and the New York canal problem.

All these authorities, so far as we recall, have entirely overlooked the serious handicap to the St. Lawrence route resulting from the dangers of its navigation. We commented briefly on this several weeks ago (Eng. News, March 28) and showed that Montreal's advantage of 320 miles in the voyage to Liverpool is probably more than offset by the higher insurance rates on the St. Lawrence route. A correspondent of the "New York Tribune," from St. John's, N. F., under date of May 5, sets forth so well the present situation as to the St. Lawrence route, that we give space to a large part of the article below, as one of the most important documents which has appeared relating to the much-discussed question of Canadian competition. It may be remarked here that this same matter of dangers from fog and ice, resulting in higher insurance rates, has an important bearing on another Canadian export route, which has been discussed for a dozen years or more—that via Hudson's Bay.

The fact that Danger and Delay can offset large advantages in Distance, ought to be writ down large by anyone who studies the problem of competing transportation routes.

We quote from our contemporary as follows:

Canada is exceedingly disturbed over the growing unpopularity of the St. Lawrence route and the withdrawal therefrom of some of the leading ocean shipping lines which had hitherto made Montreal their Western terminus. The competition of the American ports is proving destructive, and the Canadian Parliament is clamorous for prompt action by the Federal Government to improve the approaches to the gulf and the river. The Dominion Line has gone to Portland, the Johnson Line to Boston, the Hamburg-American to New York, and even the Leyland Line refuses to go up the river beyond Quebec. Montreal's trade is dropping, and in the face of the appalling record of disaster which the marine insurance underwriters present as the outcome of their St. Lawrence business in the last ten years it is difficult to see how anything else can be expected.

The St. Lawrence route has long had a most unenviable repute for shipwrecks. Two years ago Lloyd's rates were increased considerably above those ruling for American ports. The Canadians cried out against this as an unjust discrimination against them and an attempt to discredit their national waterway. This year they have sought incorporation for a Canadian Lloyds, and a bill for the purpose is now before the Ottawa House. The marine insurers against whom this is aimed have met it with a statement showing the amazing extent of the losses on that route and the worthless character of the lighthouses, signal stations and other aids to navigation which line the gulf seaboard from Belle Isle to the head of tidewater. This statement is an almost destructive blow to the pretence that Canada has in the St. Lawrence a safe and advantageous shipping lane.

In brief, the document, which covers the years 1889 to 1899, inclusive, shows that during that period 28 ocean steamers were totally lost on that route, and that 84 strandings occurred, 50 of them in the channel between Montreal and Quebec. At least 75% of the losses had been in the St. Lawrence River and Gulf, and some of the disasters were to the finest steamers on the route, and were attended by loss of life. The financial aspects were equally discouraging. The insurance companies during the decade paid losses on outgoing hulls of $3,463,000 and on cargoes $3,058,000, on incoming hulls $2,500,000, and cargoes $1,526,000. Over and above the premiums actually received the companies lost $1,000,000 a year on ships and hulls, and there seems little or no prospect of improvement or any warrant for reducing the premiums again.

DANGERS ALONG THE ROUTE.

This hopeless showing is confirmed by the report on the condition of the waterway from Montreal to the Newfoundland banks, which is a section of the St. Lawrence route nearly 800 miles long and bristling with danger from fog, ice, currents and defective charts and signals the whole way. An inquiry was set on foot by the pilots and shipmasters frequenting the route as to the conditions of navigation prevailing and the improvements which could be effected. The master mariners, 33 in all, whose evidence was obtained united in the conclusion that the existing beacons were obsolete, and that not only should they be greatly modernized, but a number of new ones ought to be set up. They condemned the lights as weak, the fog signals as lacking in power, the buoys as being unreliable, the signal stations as wrongly placed and the coast as badly charted. Bad as these conditions were in the outer waters of the gulf, where no soundings could be got and the ships had sea room, they were worse in the river, where the channel was narrow and shoal, being less than 500 ft. wide and 28 ft. deep. Every facility existing along the route was of a far lower standard than the steamer captains considered necessary, and the imperfections were so many and so glaring as to be altogether inconsistent with the greatest security to life and property and the advantage not only of the large Atlantic liners, but also of all classes of shipping interested in the coasting or ocean trade.

With such conditions existing, it is not surprising that marine risks should be so high and the St. Lawrence route shunned by most of the large shipowners. Even tramp steamers avoided it, because the burden was so excessive. Insurance rates there have been so arranged of late that a ship paying 4½% to Baltimore would pay 9, 10, or even 11% to Montreal. This would mean an extra charge of $25,000 on a boat worth half a million making five round trips there during the season of open navigation, which is about seven months—from May to November, inclusive. These charges frighten shipowners off, and they seek charters at the American ports, without much difficulty in obtaining them, the result being that freights are diverted from Montreal to the competing ports, crippling Canada's great emporium more and more every year.

COMPARISON OF EXPORTS.

How great this injury is can be realized by the fact that the United States exports annually 200,000,000 bushels of wheat and flour, 200,000,000 bushels of corn and an equal dead weight of oats, barley, bacon, pork and kindred commodities. Canada's largest exportation of grain in one year was but 44,000,000, and much of this came from the American West, because until the last two or three years a goodly stream of United States products flowed out through the St. Lawrence, it being the shortest and most direct route to Europe. But the frequent losses, the increasing insurance and the general dissatisfaction compelled them to turn to the cheaper and safer, if longer, route by the American ports. The other side of the matter is now seen in the fact that the Canadian province of Manitoba last year exported 56,000,000 bushels of grain to Great Britain, and out of that quantity less than 14% went by way of Canada, the other 86% going out through American channels. Montreal last season did a much smaller grain export trade than for some years previously, and with the withdrawal of the steamer lines now announced it is certain to be less than ever this year.

ESTIMATED COST OF IMPROVEMENTS.

To improve the St. Lawrence route to an extent which would enable it to compete with Portland, Boston or New York will involve an expenditure of $5,000,000, and such an outlay the Canadian Government is not disposed to undertake until it is satisfied that Montreal can continue to be the great national port of the Dominion. The danger of this lies in the fact that Quebec is really the natural harbor, whereas to reach Montreal involves dredging the river up to that point, a distance of 180 miles. The present depth of water is about 28 ft., and the present demand is for a depth of 30 ft. But New York is now planning for a 40-ft. channel, and the question is asked whether Montreal can hope to equal this, or whether, even if it can, it is wise to attempt it with Quebec available at such a short distance away. In olden times of railway running the transfer of grain or other products over a distance of 180 miles was a serious matter, but nowadays, with the growth of railway plants and the economies in operation, this problem loses much of its seriousness. Consequently, Canada's wisest men are halting to consider whether the center of commercial gravity should not be shifted to Quebec, especially as such huge ships are now being built every year, demanding much in the way of sea room. So much are the Western grain men, both Canadian and American, influenced by this reasoning that they are already shipping wheat to Quebec to supplement the lumber cargoes which are generally leaded there and will admit of considerable grain being stored in the lower holds into which it is difficult to stow the deals. Canada last year thought to stimulate Montreal's grain trade by completing the deepening of her canals to 14 ft., but the project did not meet the success anticipated, the benefits therefrom being neutralized by the disasters along the St. Lawrence seaboard. The projected extension and deepening of the New York state canals, now under consideration, is also a source of much uneasiness to Montreal, it being felt that this will endanger her commercial prestige more than anything so far experienced.

The friends of Montreal argue that it is the natural steamship terminus for Canada, because it is the end of navigable water for ocean-going ships. Her advocates say:

Improve the gulf beacons and lights; provide for a proper hydrographic survey of the river at a cost of $50,000; dredge the river and widen the channel; abolish the port duties now charged at Montreal, and make it a free port, like some of the American harbors; abolish the rates now charged by the canals, which would cost $200,000, but would probably divert a large volume of grain traffic to them, and erect some large elevators at Montreal, which would contain an immense stock of wheat and admit of its expeditious and economic shipment.

These improvements may do much in the line indicated, but the great drawback to the St. Lawrence route is the narrow channel, or Strait of Belle Isle, shrouded in fog and dotted with ice masses almost the whole season through. Practically all the big shipwrecks have taken place in this part of the route. Even the most perfect appliances for warning ships are almost valueless in a region like this, and while the Montreal boats go by the Belle Isle route the reputation of the route must suffer.

The alternative would be to proceed via Cabot Strait, on the south of Newfoundland, which is 60 miles wide and has few obstructions. But that involves a day's delay, and shipowners will take the risk of the former rather than keep their vessels out a day. Between the one route and the other Canada's maritime trade is being severely injured, and the American ports are reaping the benefit.

A vessel leaving New York for Europe is in the open sea in about five or six hours, with all dangers past save those incidental to midocean; but a vessel leaving Montreal has about a thousand miles to traverse, occupying, say, three days, with more or less dangerous and intricate navigation, before she passes Newfoundland and enters the high seas, where alone she can be placed on a parity with the steamer leaving New York. And, as a formidable list of disasters has already been quoted which have occurred in the gulf and river within the last ten years, it is clear that this is the weak link in Canada's chain of communication with Europe.

LETTERS TO THE EDITOR.

What Causes the Saturation of the Soil of a Roadbed as the Frost is Going Out?

Sir: In your issue of May 2 Mr. Gillette, in criticising my article on "Construction and Care of Earth Roads," says: "Saturation of a roadbed is not due to subsurface flow caused by hydrostatic pressure, but is due to damming of the ditches by snow and slush." This may be true at times, but it is not the only cause, nor even the usual one. Saturation frequently occurs as the frost is going out, when there is not a particle of snow on the ground. Mr. Gillette appears to be discussing the effect of snow, and his facts and conclusions have no relation to the statement to which he takes exception (see Engineering News, April 18, fourth paragraph of the first column).

Ira O. Baker.

University of Illinois, May 7, 1901.

Concerning the Goodyear Dynamite Work on the Brunswick Bar.

Sir: Referring to your editorial notes in the issue of April 18 of Engineering News, on the subjects of Captain Gillette's final report on survey of Brunswick Outer Bar, Georgia, and of the defeat of the River and Harbor bill, I beg to submit that while attempting to defend the Corps of Engineers of the army from unjust criticism, you have done a great injustice to the profession of civil engineers. For instance, because Congress has seen fit to permit a private citizen to experiment with dynamite upon an ocean bar, and to pay him for results obtained, would seem to be no reason why the works of river and harbor improvement—works of a purely civil character—should not be intrusted to the care of the members of a distinguished profession, to be executed by scientific men in a scientific way. Yet this seems to be the conclusion you have drawn, where you say "the evils of present methods of conducting river and harbor works are many; but a mere transfer of control of the work to civilian (?) engineers would effect nothing to remedy them. Rather, if we may judge from such fiascos as that at Brunswick Bar, it might open a wider door to corruption and extravagance."

The editorial notes go on to say, further: "The United States has paid to Mr. Goodyear $220,000 for his work, and has expended about $27,000 more in surveys to determine what improvement has been made on the bar. In all, therefore, about a quarter million dollars of public funds have been spent in a Quixotic experiment, doing work that an ordinary dredge would have done for less than $20,000."

And again: "The government engineers from the beginning advised Congress against expending money upon the Goodyear experiments; but Congress in its wisdom (?) thought it a good scheme to let Goodyear try, as they let Dyrenforth try, and the final result is a waste of public funds."

We shall not undertake to say that these are not legitimate conclusions from the report quoted, but it is believed that if you were in possession of all the facts you would hesitate a long time about drawing these conclusions yourself.

It is not my purpose at this time to enter into any lengthy discussion of the merits either of the Goodyear work or of Captain Gillette's report, but it seems proper to remind the News that at the time Congress authorized Mr. Goodyear's dynamite work it was confronted with a project by the government engineers for the construction of jetties to cost nearly $3,000,000, and about which Captain Gillette now says that the interest, at 3%, on the cost of the jetties proposed would be probably much more than enough to annually create, by dredging the channel, depths and widths required by the act.

If this be true, the expenditure of a quarter million dollars to demonstrate this fact is not entirely wasted. It is no more than justice to Mr. Goodyear and to Congress, however, to state that Mr. Goodyear not only secured the depths required by his contract, but he also maintained those depths for many years without cost to the government. When it is remembered that the government is expending annually from $45,000 to $50,000 in addition to the cost of the plants for maintenance alone at such places as Charleston and Galveston, where jetties have been constructed at a cost of many millions of dollars, the expenditure of a quarter million at Brunswick seems the height of economy; and to assume that the results there accomplished could have been done for less than $20,000 is not warranted by the record of government expenditure for such work anywhere.

In conclusion, I beg to enter a vigorous protest against such statements in your editorial notes as this: "The fact is, as every intelligent engineer or contractor knows, that to explode dynamite on an ocean bar in the hope of creating a channel was about as likely to accomplish valuable results as General Dyrenforth's bombardment of the Texas skies to make rain fall."

My observations of the actual dynamite work, both at Brunswick and at Aransas Pass, and a study of the results at both of those places, have led me to entirely different conclusions from those of Captain Gillette, and I regard the value of the use of dynamite, where the conditions are favorable, as fully demonstrated; and it seems to me that every intelligent engineer or contractor who could realize the possibility of dynamite explosions upon an ocean bar putting the material in a condition to be more easily scoured by the currents, would naturally reach the conclusion that its use might be of the greatest utility in accomplishing valuable results.

In my judgment it would be extremely unfortunate for the progress of engineering if your conclusions should be taken seriously by any great number of the profession to the extent of deterring them from further use of dynamite in the direction indicated.

Very truly yours,

Chicago, Ill., May 7, 1901. H. C. Ripley.

(Our correspondent, judging from the first paragraph of his letter, appears to have slightly misunderstood our remark that "a mere transfer of control of River and Harbor works to civilian engineers would effect nothing in the way of remedying evils in present methods." He evidently has the idea that such a transfer would place the work in the hands of "members of a distinguished profession, to be executed by scientific men in a scientific way." But no one has ever found out how to effect such a happy result. When you open the door to Congressional influence and divers other "influences" with which Washington teems to select the engineers to be placed over contractors doing millions of dollars' worth of Government work and rejoicing, very likely, in the possession of strong political pulls—when you make this transfer, then say good-by to honesty in River and Harbor work. The "members of a distinguished profession," the "scientific men who do work in a scientific way," will not be in demand. Even if they by good fortune are placed in charge of work, what will happen when they come in collision with some contractor who is perhaps a liberal contributor to campaign funds? We do not mean by any means to draw a sweeping indictment of Government contractors. Under the present system, contractors know that they must do honest work. Change the system so that "influence" can dictate the appointment of the engineer, and the honest contractor will have no chance against the man who bids on the strength of his political pull.

As to the value of dynamite for excavating a bank of silt and mud, we can only confess our surprise that an engineer of Mr. Ripley's standing and experience should approve it.—Ed.)

A DECISION IN FOUR UNDERGROUND WATER cases was handed down by Justice Gaynor in the Supreme Court, Brooklyn, N. Y., on May 3. The four plaintiffs had sued for heavy damages on account of the lowering of the ground water level of their celery and lettuce farms by the operation of the city pumping stations in their vicinity. They claimed that the lowering of the water table deprived their soil of the moisture needed for the crops. Justice Gaynor sustained the contention of the city that the damage, if any, was a mere trifle, and awarded $350 to one of the plaintiffs, who had claimed $21,000, and $100 each to the other three, of whom one had claimed $8,000 and the other two $4,000 each. The cases will probably be appealed, and several other suits are pending.

STEEL BOX CARS of 80,000 lbs. capacity have been built for experimental purposes by the Atchison, Topeka & Santa Fe Ry. They are 40 ft. long and have six horizontal sills and two end sills, all composed of 10-in. channels. A particular feature of the underframe is that it is self-supporting, no truss rods being used. The sides, ends and roofs are of No. 10 steel plates, riveted to the side sills and to a 6-in. channel wall plate. The doors are of wood, and the inside is floored and sheathed with wood. Diagonal bracing of flat bars is riveted on top of the sills, and over the sills are the nailing strips for the floor. The cars have cast-steel bolsters and are mounted on diamond trucks. The weight, empty, is 44,900 lbs.

THE WIDENING OF FIFTH AVENUE, New York, to 56 ft., by reducing the sidewalk width from 30 to 22 ft., was voted down on May 8 by the Board of Public Improvements. As originally laid out, Fifth Ave. was to be 100 ft. wide between house-lines, with two sidewalks each 20 ft. wide. In 1882 the City Council and Mayor authorized the narrowing of the roadway to 40 ft., and extending the width of each footway to 30 ft. This resolution also permitted owners to inclose 15 ft. of the sidewalks for ornamental courtyards, etc., though it was provided that the Council could rescind this permission at any time. Mr. Louis R. Risse, the chief topographical engineer of the Board of Public Improvements, recommended the increase of roadway width to 56 ft., the rescinding of the courtyard provision, and the limiting of the stoop-line to 7 ft. beyond the house-line. The report states that this widening of the roadway is necessary to relieve the present congested condition of traffic on the avenue. The only reason given by the Board for refusing to authorize the proposed widening was—that Fifth Ave. was the only avenue left in the city with sufficient sidewalks for the people to walk upon. But no reference was made to the reasons for still permitting householders to enclose half of the existing sidewalk space, as at the Waldorf-Astoria etc. The city has the right to rescind this privilege, and thus to add largely to the traffic facilities on this thoroughfare, both for wheeled traffic and foot passengers.

HEAVY TANK LOCOMOTIVES for suburban train service are to be introduced on the New York Central R. R. the heavy weight on the driving wheels enabling a rapid acceleration to be attained after stops, with little slipping of the wheels. These engines have six driving wheels, a two-wheel or pony leading truck, and a six-wheel truck under the tank. The engines are being built by the Schenectady Locomotive Works, and their prinicipal dimensions are as follows:

Driving wheels	5 ft. 3 ins.
Wheelbase, driving	15 " 0 "
Wheelbase, total	35 " 9 "
Weight on drivers	120,000 lbs.
Weight, total	205,000 "
Cylinders	20 x 24 ins.
Boiler, diameter	5 ft. 10 "
Working steam pressure	200 lbs.
Fuel	Anthracite
Heating surface	2,400 sq. ft.
Grate area	33 "
Water in tank	3,500 gallons
Coal in bunker	4 tons

A NEW RAILWAY WATCH is being made in France, Germany and Switzerland, which divides the hour into 10,000 parts, instead of 18,000 parts, as in the ordinary watch, which divides time by fifths of seconds. The face of this watch is divided from 0 to 24 for the hours, with a slightly different figure for the hours from noon to midnight, so that the ordinary notation can be used if required. The seconds and fractions are recorded on three separate dials, and as each division on the scale is indicated by a double beat, time can really be read to the 1-20,000th of an hour. The watch is intended for railway use and close timing operations of any kind.

STEAM STORAGE LOCOMOTIVES (without fireboxes) on the system invented in France by Mr. Francq have been in use since 1883 by the street railway company of Batavia, in the Dutch East Indies. The engines are used on a line 8 miles long, practically level, with minimum curves of 82 ft. radius. The gage is 3.87 ft. There are 27 locomotives, weighing 7 tons empty, and 18 of these are normally in service, hauling trains of four cars. The operating expenses are about 48% of the gross receipts, and this low ratio is attributed largely to the efficiency of the engines and their low cost for maintenance and repairs. The coal consumption of the stationary boilers which heat the water for the locomotives was 6,916,910 lbs., using Australian coal, which cost $7.00 per ton delivered at the station. The average consumption per train mile was 14.47 lbs. Adding to the above expenses the cost of oiling and repairs, it is found that the expenses for traction do not exceed 8.47 cts. per train mile, of which the fuel cost represents only 4.84 cts. The 27 locomotives have made a total mileage of 7,013,520 miles, of which 493,756 miles were run during the year 1899-1900.

THE DECOMPOSITION OF PORTLAND CEMENT in sea water is commented upon by Baron de Rochemont in the "Annales des Ponts et Chaussees" for May, 1900. He says that Dr. Michaelis pointed out that free lime in the cement was the principle cause of trouble, it uniting with certain sulphates in the sea-water and causing by this combination a destructive increase in volume. To remedy this evil Dr. Michaelis recommended the addition to the Portland cement of certain portions of pozzuolana, or trass, which, combining with the free lime, would fix it and render it incapable of doing harm. The Prussian Minister of Public Works appointed a commission to experiment upon the proposition and theories of Dr. Michaelis, and this commission lately made its report. In substance the commission finds that the addition of trass, within certain limits, renders Portland cement mortar better adapted for use in sea-water. To fix the proportions of trass and cement so as to realize the best results, however, it will be necessary to experiment especially upon a large scale, and to extend the observation of results over a long period. Experiments of this character are already projected. In this same connection Orazio Rebuffat, an Italian engineer, has been analyzing pozzuolana mortars, some of which have been lying 35 ft. under the sea at the port of Pozziuli for nearly 2,000 years, and others of which are modern mortars from the port of Naples, about 20 years under the water. He also experimented with similar mortars immersed in fresh water. He concludes that pozzuolana mortar immersed in sea-water undergoes, in the first few years of its immersion, a very radical chemical change, which finally renders it indifferent to the chemical action of sea-water. At the end of this first period the mortar has lost almost all of its lime, and is transformed into a hydrated silicate of aluminum, with traces only of lime, magnesia and alkalies.

STEEL TIES are being experimented with by the Lake Shore & Michigan Southern Ry. The ties are of a type invented by one of the roadmasters, Mr. C. Buhrer, of Sandusky, O., and consist of old 65-lb. rails cut in 8-ft. lengths, and having an 8-in. steel plate riveted to the base, the rail being inverted. The inventor has patented a die in which the old rails would be rolled into an I-beam section, as noted in our issue of Dec. 6, 1900, but this would be too expensive except for large orders which would warrant the cost of new rolls. There are 150 of these ties, spaced 2 ft. c. to c.

ELECTRIC POWER DEVELOPMENT IN SWEDEN is reported upon by a correspondent of the New York "Journal of Commerce." A concession has been granted for building an electric railway from the port of Sundsvall, on the Baltic, to Bengfors, at a cost of $600,000. The line will be about 22 miles long, of narrow-gage, and be chiefly used in hauling timber products. The Stockholm Tramways Co. has decided to convert its lines from horse to overhead trolley lines. The current will be taken from a new electrical plant now being constructed in that city at a cost of about $2,000,000. The Falc Electric Light Co. has purchased a water power in the neighborhood of that city and will soon substitute hydraulic for steam power in the generation of electricity. The State of Sweden is also inviting tenders for the use of the Alkarleby waterfalls, between Stockholm and Gefle, and these falls may be soon utilized for working electric railways in the district.

DRAFTSMEN FOR THE NAVY are wanted, and an examination of applicants will be held at the New York Navy Yard on May 23, or as soon after as practicable. One mechanical draftsman is to be appointed, at $4.48 per day, and two assistant architectural draftsmen, at $4 per day. The positions are open to all citizens of the United States who can give evidence of proper experience. Applications should be addressed to the Commandant, Navy Yard, New York, and this application should state name, age, residence, citizenship, present occupation and previous employment, and should be accompanied by certificates as to character, habits of industry and sobriety, etc. Applicants will be notified of the dates upon which they are to appear for examinations.

THE NATIONAL DEBTS OF THE WORLD are discussed by the Treasury Bureau of Statistics. These now aggregate $31,000,000,000; whereas they were only about $2,500,000,000 in 1793, showing an increase of ten times in about one hundred years. But in this same period the population has increased 150% and gold and silver money 300%. It is difficult to estimate the increase in the world's wealth in the same time. In 1800 the estimated wealth of the United Kingdom, France, Spain and the United States was $20,244,640,000, while in 1895 Mulhall estimates the wealth of these same countries at $195,759,829,000. The debts of these four nations in 1793 aggregated but $1,630,279,000, and they are now $11,764,000,000. These debts represent wars, railways, canals, improvement of waterways, etc. The national indebtedness of the world increased, between 1848 and 1862, from $8,419,045,000 to $13,382,375,000, and the next ten years to 1872 added nine billions to the aggregate; in the decade 1882-1901 about five billions were added.

TRIALS OF MOTOR VEHICLES FOR HEAVY TRAFFIC will be conducted by the Liverpool Self-Propelled Traffic Association on June 3 to 7. The object of the trials is to provide a means of making a preliminary test of types of heavy motor wagons suitable for haulage operations in Lancashire, prior to their being taken over by a syndicate which will be formed for the purpose of conducting road transport between Liverpool and neighboring manufacturing towns. The program of the trials includes hill-climbing, manoeuvring and long-distance road tests. Competing vehicles are to be divided into four classes carrying loads of 1½, 4 and 5 tons, and 5 tons with no limit of tare, respectively. Thirteen British manufacturers have already signified their desire to compete. Further particulars and the rules and conditions of the trials can be obtained by addressing the Secretary of the Association, E. Shrapnell Smith, Royal Institution, Liverpool, England.

NOTES FROM THE ENGINEERING SCHOOLS.

TECHNICAL HIGH SCHOOL OF BERLIN, GERMANY.—During the semester of 1900-1901 there were in attendance at this school 3,107 students, as against 2,750 in the winter of 1899-1900. In addition, there were 1,236 persons who attended lectures, making a total attendance of 4,343. Of the students, 2,336 were from Prussia, 403 from the other German states, and 368 from foreign countries, 12 of whom were from the United States.

UNIVERSITY OF MICHIGAN.—A rotary tube mill for grinding Portland cement has been added to the equipment of the laboratory of chemical technology. The apparatus, although it is of laboratory size, is modeled after the larger machines used in cement works. It was presented to the University by the Bonnot Co., of Canton, O.

BRADLEY POLYTECHNIC INSTITUTE.—This school, which is located at Peoria, Ill., has established a department in which is taught watch-work, engraving, jewelry, clock-work, optics, etc.

OHIO STATE UNIVERSITY.—In order to facilitate experimental and research work on the combustion of fuels under variable conditions as applied to steam generation, there has been installed during the past year in the University boiler-house, a very complete experimental boiler outfit. This equipment was furnished by Stillman W. Robinson, Emeritus Professor of Mechanical Engineering. The following description is abstracted from the catalog of the College of Engineering:

A Babcock & Wilcox boiler of 107 HP., built for a working pressure of 200 lbs., with hand fired furnace of the oven fire-brick arch type, is used. The products of combustion after passing the boiler can be conducted direct to the open air by the chimney, or into a Green's fuel economizer, having 570 sq. ft. of heating surface. The heat of the escaping gases can still further be absorbed by an air heater having 1,330 sq. ft. of heating surface. The heat thus taken up is transmitted to the air supplied to the furnace.

Natural draft may be employed, or when greater intensity of draft is desired above that produced by the chimney, the latter can be cut out and a Sturtevant induced draft fan driven by a direct-connected engine brought into action. In combination with either mechanical induced or natural draft, forced draft produced by a belt driven Sturtevant fan, may be employed, and the air forced into the ash pit may be taken from the boiler room direct, or by a system of underground flues be compelled to pass through the air heater on its way to the fan.

Weighing and collection tanks in conjunction with a steam pump supply the boiler with known quantities of water. In this feed water system is a Hayden's feed water purifier with live steam heater, which may be used in conjunction with the economizer. Draft intensity and temperatures are determined at many points throughout the system, a Le Chatelier pyrometer being used for high and mercurial pyrometers for low temperatures. An Arndt's econometer indicates continuously the percentage of carbon dioxide in the escaping gases, while at the same time the Orsat's apparatus is used for giving absolute composition.

ANNUAL CONVENTION OF THE NATIONAL MUNICIPAL LEAGUE.

The annual meeting of the National Municipal League was held at Rochester, N. Y., May 8 to 11. A large part of the time of the convention was devoted to a review of reform movements in different cities and to charter legislation, reform and retrograde, in New York and Pennsylvania.

With the apparent view of broadening the usefulness of the league and furthering the common objects of both itself and other organizations, an effort has been made to secure the co-operation of various business bodies, like boards of trade and chambers of commerce. Some ten or a dozen such organizations have agreed to this plan, and others have it under consideration.

The work of the American Society of Municipal Improvements was reviewed by Mr. N. P. Lewis, M. Am. Soc. C. E. He thought the various associations devoted to municipal affairs could do better work as separate bodies than if consolidated, as has been suggested of late. A resolution was adopted later on, requesting the executive committee of the league to invite the American Society of Municipal Improvements, the League of American Municipalities and kindred organizations to hold a conference some time next year.

COLLEGE INSTRUCTION IN MUNICIPAL GOVERNMENT.

One of the most interesting features of the meeting was a report of a Committee on Instruction in Municipal Government in American Educational Institutions. This report was presented by Dr. Thos. M. Drown, of Lehigh University, chairman of the committee. Letters sent to 357 colleges and universities had resulted in 222 replies, of which about 40 had stated that the institutions concerned had courses of instruction in municipal government. The committee is working on a bibliography for the guide of those who are teaching municipal government, and it is also preparing suggestions for a course of study. A subsequent speaker suggested the need of endowments for special chairs of municipal government, and also of the need of more research work. The committee was continued.

THE CHICAGO STREET RAILWAY SITUATION.

A paper on this subject, by Mr. Wm. Ritchie, showed that the problem of street railway franchises in Chicago is still very far from being settled. The legislation recommended in the report of the street railway committee (see Engineering News, Jan. 10, 1901) was defeated at the State Capitol, but Mayor Harrison, who has been elected three times on this issue, still holds firm in his determination not to let the street railways have everything their own way in the future. The author of the paper declared that the street railway service of Chicago is inferior to that of cities of 200,000 population.

UNIFORM MUNICIPAL ACCOUNTING.

All of the last session of the convention was devoted to this subject, and in addition a conference of committees on accounting from various societies was held on Saturday forenoon.

Dr. E. M. Hartwell, the head of the Boston department of statistics and chairman of the committee on municipal accounts and statistics, submitted a report on the work of the committee. Three meetings have been held and a tentative schedule for summaries of municipal receipts and expenditures has been prepared. The scheme proposed involves a grouping of receipts and expenditures under the various municipal departments, besides consolidated statements of receipts and expenditures for the year and an analysis of both ordinary and extraordinary revenue by sources. One of the schedules, showing receipts and expenditures by departments, has already been used in the report of the city auditor of Newton, Mass., for 1900, through the co-operation of that officer and Mr. Harvey S. Chase, of Boston, a member of the committee. The department of statistics of Boston has also undertaken to apply the same schedule to the accounts of that city for 1900, under the direction of Dr. Hartwell. Still another member of the committee, Mr. Chas. Haskins, of New York, has recommended that the scheme be applied to the accounts of the city of Chicago. It may be added here that Messrs. Chase and Haskins are both experienced public accountants, so that these men, in conjunction with Dr. Hartwell, place the work of the committee on an eminently practical basis. The schedules proposed by the committee are based on a classification suggested by Prof. L. S. Rowe, of the University of Pennsylvania, in a paper presented by him, in 1899, before the meeting of the National Municipal League, at Columbus, O.

As to municipal statistics in general, Dr. Hartwell suggested that to secure these the organization of bureaus of municipal statistics, like those of European cities, would be a great help, and that much assistance could be expected from the various organizations closely related to municipal public works.

Mr. Chas. Haskins presented an interesting paper on the confused and confusing condition of the accounts of the city of Chicago, including the many independent boards and taxing bodies within the city limits. He has made a report on the general subject to the Merchants' Club of Chicago, which has been printed for distribution.

A review of public control of municipal accounting in Continental Europe was presented by Dr. John A. Fairlie, of the University of Michigan. France, Italy and Germany have a central audit of municipal accounts, the latter country being weakest in this respect. Summaries of municipal statistics are published by both France and Italy, but those of France go less into detail than those of Italy. Paris has a statistical bureau which issues valuable summaries, both yearly and at more frequent intervals. The German cities publish good municipal statistics, in addition to which a voluntary association of statistical officers publishes a valuable municipal year book, including classified statistics under various heads for from 45 to 52 of the largest cities of the Empire. In Austria a summary of municipal statistics has been published for seven years, on the cumulative plan.

The closing paper was by Mr. G. W. W. Hanger, Chief Clerk of the U. S. Department of Labor. He gave an interesting and comprehensive review of the difficulties encountered by the department in the preparation of its statistics of cities of 30,000 and upwards, issued in 1899 and 1900 and now in preparation for 1901. The greatest of these difficulties is lack of uniformity between the different cities and between the various departments of the same city. Special assessments for public improvements are the cause of endless trouble in trying to arrive at the expenditures for different purposes. There is very often a great confusion between outlays for construction and expenditures for maintenance.

THE CONFERENCE ON UNIFORM MUNICIPAL ACCOUNTING.

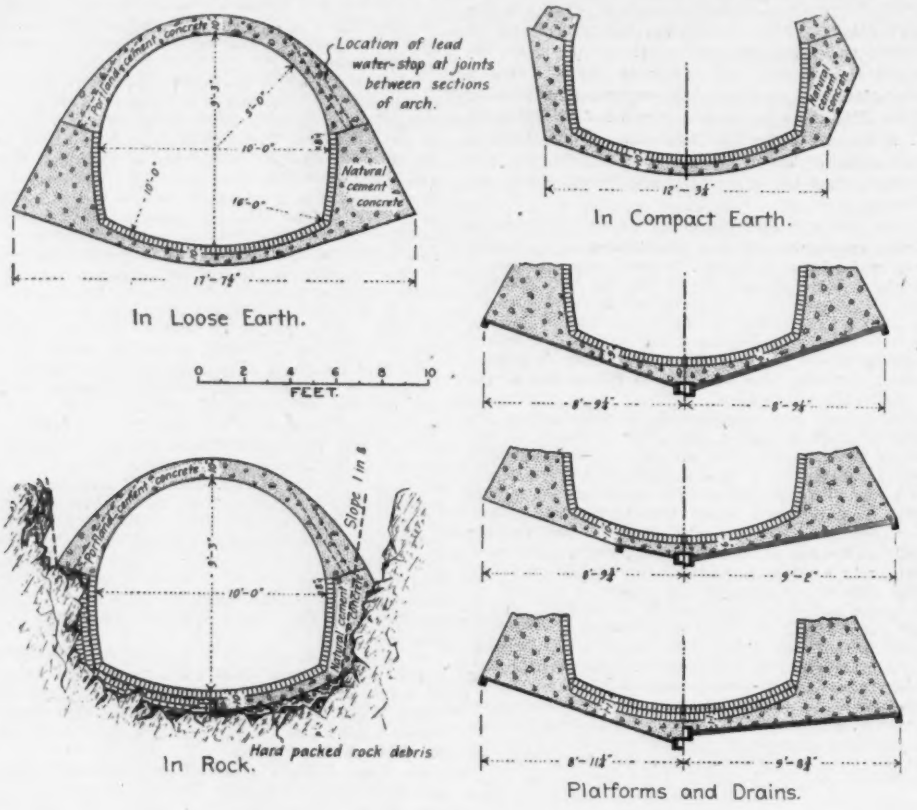
A few persons, outside of the members of the committee of the league, attended this conference. The other organizations represented were the American Statistical, Economic and Public Health Associations, respectively, and the New Jersey Sanitary Association. The conference approved the tentative schedules for summaries of receipts and expenditures, already mentioned. It also approved the Bertillon classification of causes of deaths, as modified by an international congress of sanitarians, held at Paris in 1900, and as adopted by a number of American medical and sanitary associations and many American states and cities.

Reports from various members of the conference showed that a very complete system of uniform street railway accounting has been adopted by several organizations interested in that subject and ordered put in use by com-

panies making returns to the State Railroad Commissions of some of the states. A committee of the National Electric Light Association has prepared a comprehensive report, with accounting schedules, for submission to the annual convention of that body at Niagara Falls the last week in May. Committees of the New England and the American Water-Works Associations, and also the American Society of Municipal Improvements, prepared schedules for summaries of water-works statistics some years ago. The schedule of the latter is comparatively recent. The New England schedule has been in use by a few works for many years. The American Society of Municipal Improvements has also prepared an outline plan for both sewerage and paving statistics. The conference requested Mr. Harvey S. Chase, of Boston, to confer with the committee of the National Electric Light Association in regard to its proposed scheme of accounting; also to confer with committees dealing with gas accounts and statistics. Mr. M. N. Baker, of the editorial staff of this journal, was requested to confer with committees charged with securing greater uniformity in the statistics of municipal engineering, and particularly to see what can be done towards the adoption of a common schedule of water-works statistics by the American, New England and Central States Water-Works Associations and the American Society of Municipal Improvements. It was considered desirable that progress in this particular should be made before the convention of the American Water-Works Association, to be held in New York city the latter part of June. It was suggested that there was less difference than there appears to be between the schedules of the New England Water-Works Association and the American Society of Municipal Improvements.

THE WESTON AQUEDUCT OF THE METROPOLITAN WATER-WORKS FOR BOSTON AND VICINITY.

Bids for portions of a large aqueduct for the water supply of Boston and vicinity were received by the Metropolitan Water and Sewerage Board on April 30. Some details of the structure are shown by the accompanying drawings. A note describing the Weston aqueduct, as it is to be called, was published in our issue of Feb. 7. It will extend from the Sudbury reservoir, in Southboro, Mass., towards the Metropolitan water district for a distance of 13.4 miles. For the first 3½ miles, it will have a grade of 1 in 1,250, a width of 10 ft., and a height of 9¼ ft. The remainder will have a grade of 1 in 5,000, and will be 13 ft. 2 ins. wide and 12 ft. 2 ins. high. There will be several tunnels.



The design of the structure will be similar to that of the Wachusett aqueduct, built by the board in 1896-7.* In general, the new aqueduct is to be of concrete, with a brick lining for its lower portion. In rock tunnel the lining will be wholly of concrete. Fig. 1 shows a number of proposed sections of the aqueduct where in embankment. They need no comment, except as to the lead water stops, in the concrete, shown in the two full sections at the left, and the details of the drains, at the right. Both these features have been explained by Mr. A. D. Flinn, Assoc. M. Am. Soc. C. E., Principal Office Assistant in the engineering department, as follows:

> The experience on the Wachusett aqueduct has been that if transverse cracks have occurred, they have always been located at the joint between two days' work, and never in the monolithic section built continuously in one day, no matter how long such a section was. If I remember rightly, about 60 ft. was the maximum length built in one working day. The expectation is that the hinge in the lead (see sketch sent by Mr. Flinn, Fig. 2—Ed.) will allow the slight movement that may accompany the cracking, and still prevent the passage of water through the crack.
>
> The grooved and the fluted boards are to be used for platforms in the bottoms of wet trenches to carry the water directly to the box drain under the center of the aqueduct, and afford a dry and firm platform on which to lay the concrete. The fluted boards are used where there is the greater quantity of water, and are turned with the fluted side down upon 1-in. common boards.

Some of the culverts for conveying small streams beneath the aqueduct will be closed; others will be free draining, and still others partly free-draining. Some will be of masonry and

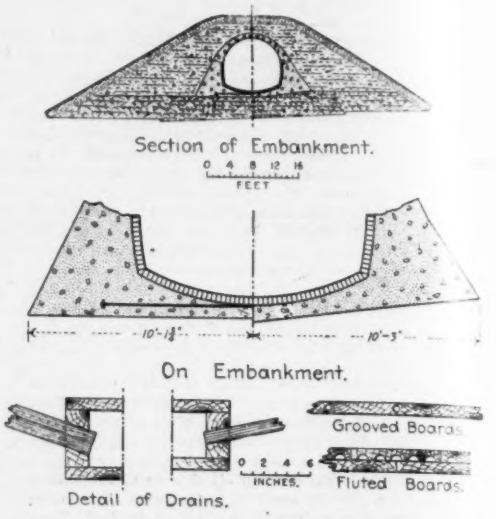


FIG. 1. SECTIONS OF WESTON AQUEDUCT IN EMBANKMENT.

F. P. Stearns, Chief Engineer Metropolitan Water and Sewerage Board.

some of pipe. A siphon chamber, to be used where the aqueduct changes to three lines of siphon pipes, is shown by Fig. 3.

An interesting preliminary study for carrying the aqueduct between the double tracks of the New York, New Haven & Hartford R. R., at Nobcot Station, is shown by Figs. 4 and 5. The aqueduct here is depressed slightly, its height is lessened and its width increased. Steel I-beams, curved

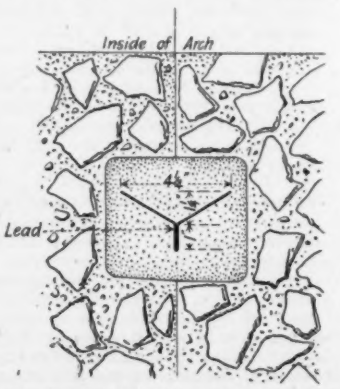


Fig. 2. Details of Lead Water Stop, Placed Between Sections of Aqueduct Completed Each Day.

to conform to the arched roof, are built into the concrete. These are tied longitudinally, in the central portion, by four rods, all as shown in the sections. It will be noticed that the depressed portion of the aqueduct has a partition lengthwise through its center. The object of this is to afford a footway for men inspecting or cleaning the aqueduct, when the water is drawn out; also to aid

*The Wachusett aqueduct was described, with numerous illustrations and extended extracts from the specifications, in Engineering News for Jan. 23, 1896, and Feb. 25, 1897. The metropolitan water-works as a whole was described in our issue of March 7, 1895.

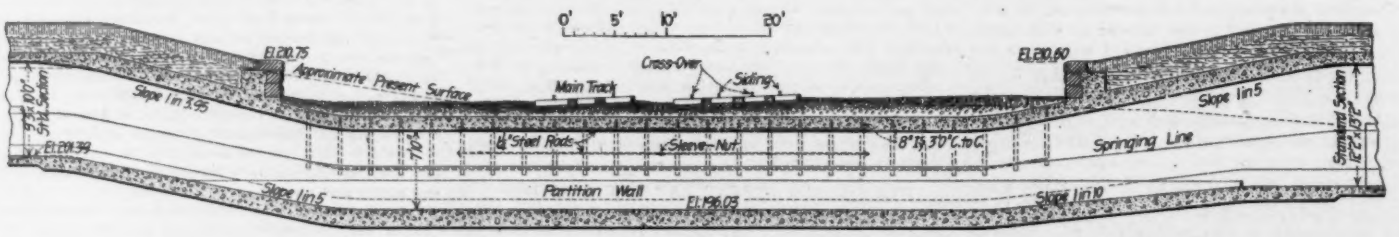


FIG. 4. LONGITUDINAL SECTION OF PRELIMINARY DESIGN FOR CARRYING AQUEDUCT BENEATH RAILWAY.

in the cleaning of the bottom of this portion. This is necessary because it is not feasible to drain the depressed part directly.

Mr. F. P. Stearns, M. Am. Soc. C. E., is Chief Engineer of the Metropolitan Water and Sewerage Board. We are indebted to him and to Mr. Flinn for the information here given.

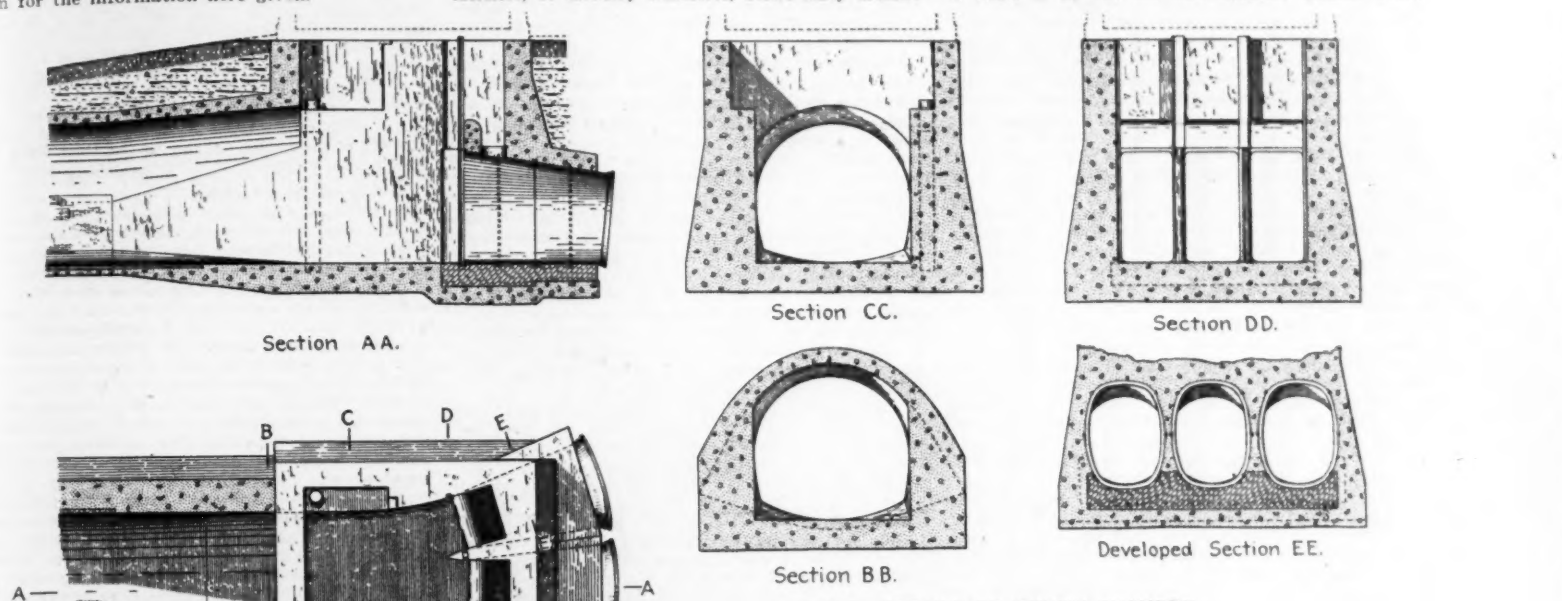


FIG. 3. DETAILS OF SIPHON CHAMBER, WESTON AQUEDUCT.

THE PROBLEM OF ALL-RAIL TRANSPORTATION ACROSS THE HUDSON RIVER AT N. Y. CITY.*

By C. W. Buchholz,† M. Am. Soc. C. E.

It is a curious fact that while several corporations and a few prominent men of New York city and a great many people from the provinces have for years past advocated bridges and tunnels across the North River in order to connect the railways terminating on the Jersey shore with Manhattan Island, the city of New York, as a municipality, more interested than anybody else, has never given this question any serious attention, and the railway companies, generally wide-awake where profit is to be made, have considered this problem so far only as a matter of gossip. The people of New Jersey, being naturally opposed to bridge or tunnel for very obvious selfish reasons, have never cried out very loudly for either of them. It seems, therefore, pertinent to ascertain the reasons for this indifference on the part of the wealthy municipalities and rich railway companies, when we read in many a pamphlet and prospectus how absolutely necessary it is to bring Jersey City and New York together by railway if the latter city wants to maintain its metropolitan character.

It is alleged that crossing of the river by means of floating equipment is frequently dangerous, on account of fogs and possible collisions; that it is costly and uncertain, on account of ice; yes, some years ago, when one of the companies was trying to borrow money to bridge or tunnel the river, I forget which, I saw a statement in one of the London papers that New York city was isolated from the rest of the continent some two or three months every year on account of the ice in the Hudson River. Of course, these statements can be verified or refuted by facts, and there is no doubt that every railway company and every ferry company have the necessary statistics on hand.

The first question relating to this problem that should, therefore, be earnestly considered, before many millions of dollars are spent for bridges or tunnels, is, are the present facilities for transporting passengers and freight across the river by means of ferries, floats and barges economical, comfortable and safe? There can be no doubt in the mind of anybody familiar with the situation that the existing facilities are able to do the work required, and that their capacities can be rapidly increased upon demand for a comparatively small cost; there is also no doubt whatever, at least not in my mind (you notice I am getting bolder and beginning to air my opinion, in spite of an inward warning), that freight will always be brought to New York from Jersey by floating equipment. Men of little experience in the detail operation of a large railroad, engineers as well as capitalists, members of the press and business men, have frequently before and are even now suggesting and considering, apparently with entire sincerity, the possibility of bringing, in train loads, to New York city all the immense traffic of freight that is daily poured into Jersey City and its adjacent towns by three trunk lines and by three railways of nearly equal importance. This freight, exclusive of coal and grain, amounts to about 30,000 tons, or 2,000 cars per day.

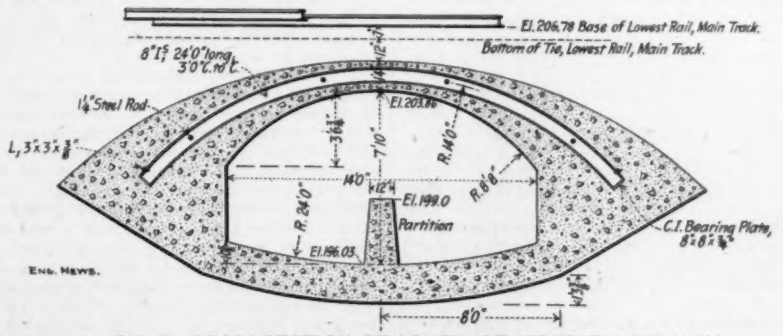


FIG. 5. CROSS-SECTION OF AQUEDUCT BENEATH RAILWAY.

The impossibility of accomplishing this proposition will be apparent to everybody when it is considered that these railway companies occupy now, with their docks, piers, stations and warehouses, more than four miles of the Hudson River front on the Jersey side opposite the city of New York, and that every one of these six railway companies has covered many hundred acres of land with its tracks for miles back from the harbor for the purpose of having adequate terminal facilities to transact the constantly increasing business with New York. To transfer all this business to one or more freight stations in this city, or only so much of it as must find its way rapidly for immediate consumption or storage to warehouses and stores without counting what goes directly for re-shipment to vessels, and to do such business with dispatch, would require an area equal to that enclosed between the two rivers and between 14th and 23d Sts., and would necessitate a network of track from one end of the city to the other, either above or below the streets. It seems to me that the most sanguine optimist would hardly dare to suggest such a scheme, and I am sure he would not be able to find an engineer to carry it out, besides, there is absolutely no necessity or demand to deliver freight by such a method to New York. Manhattan Island, with its great city, is phenomenally fortunate in its situation, although cut off by water from the rest of the continent. Its narrowness and its length, accessible everywhere to deep-draft vessels, to floats and to barges, enables the transportation companies cheaply and quickly to deliver freights and goods always at the nearest point to the warehouse or store of the merchant. Very little hauling by teams would be necessary if the city of New York would improve its river front and set apart for the use of railway companies, at certain fixed distances around its whole circumference, the necessary piers and docks to be operated by one general terminal company, whose duty it would be to receive and deliver freights to any of these points and at any of the railway depots in Jersey City.

But when the passenger traffic comes to be considered, the question is at once more complicated, as its solution depends not only upon actual statistics of that traffic as now existing, but largely upon the future direction in which New York city will develop, and more or less upon the fancy of each passenger. In round numbers about 100,000,000 people cross and re-cross the Hudson River every year, of which amount about 40% arrive by trains at the various termini of the railroads. There are now five such passenger stations at Jersey City, Hoboken and Weehawken, belonging to the Central Railroad of New Jersey, the Pennsylvania R. R., the Erie R. R., the Delaware, Lackawanna & Western R. R. and the West Shore R. R., where all passengers destined to or coming from New York, suburban as well as distant, are delivered, together with those coming from branches and connecting lines that have no termini of their own. The total number of passenger trains daily arriving at and departing from these stations is about 1,080; those trains reach and leave there on ten main tracks and are distributed at the stations upon 48 tracks provided with a corresponding number of platforms. These figures give us an approximate idea of what will be necessary to transport this traffic across the river and what will be necessary to accommodate and handle it with dispatch at the terminus in New York. But even the most sanguine advocate of an all-rail transportation to the city does not believe that all of these passengers will ever abandon the ferries. Of the whole number of people crossing the river daily approximately 75% land at or south of Chambers St. and the balance above that point. If it should be desirable to have an uptown station, into which unbroken trains can run from Jersey to accommodate this fraction of the people coming over the river, we arrive at the next important question; that is, where shall this station be located? Before going into that, I may say it is admitted by everybody that the Government of the United States, and the people of New York and New Jersey as well, will never permit a bridge to be built across the North River below 23d St. on account of its inevitable interference with navigation, and that the engineering difficulties below that street are in themselves prohibitive, so that we may fairly

*Abstract of a paper read before the New York Railroad Club, April 18, 1901.

†Chief Engineer Erie R. R., New York city.

assume that to reach New York from New Jersey below 23d St. tunnels must be resorted to, while from that point up to Fort Lee or to the Harlem River bridges must be constructed.

The New Jersey & New York Bridge Co. has located its landing at 59th St. in New York, and its terminus at 49th St. and Broadway, with a proposed approach running along West St. to the Battery. The Hudson River bridge lands at 23d St., but the site of its principal station has, I believe, not as yet been determined. The Hudson River Railroad Tunnel leaves the river at the foot of Morton St., and the company has projected its station between Third and Fourth Sts. and Fifth and Sixth Aves. To decide which of these locations is the best is entirely a matter of opinion and judgment, and the superiority of one over the other cannot be proven by any statistics or figures—especially not when the future is taken into consideration.

The next question in the problem is, shall the river be crossed by bridge or tunnel? There are a great number of prominent engineers advocates of either, and both of them are practicable, but the bridge has the great advantage that all trains, with their locomotives attached, as they come from the road, can run over it to the New York terminus and return, while it would be impracticable to do so through a tunnel, principally on account of the impossibility of securing proper ventilation there. If railway connections were to be made with the tunnel it would be necessary to detach the steam engine at Jersey and to use some other power, electricity or compressed air, to take the train to its destination. It seems, therefore, probable that if the Hudson River Railroad Tunnel is ever built, or if others are constructed, they will only be used as thoroughfares for light traffic, and that the bridge will ultimately be the connecting link between the two shores of the North River. Of course, the enormous cost of a structure to carry the traffic already outlined, the uncertainty as to where the bulk of that traffic will finally go, and the impossibility of running trains unbroken, under steam through a tunnel, are the factors in the problem before us that have caused the railway companies to pause before they go into an enterprise so uncertain in its financial results, and without the co-operation and guarantee of the steam railways terminating in Jersey City no money could be raised to carry out so colossal a plan as to bridge the Hudson River with a clear span of 3,100 ft., carrying upon its cables from 8 to 14 tracks. Not one of the bridges or tunnels now projected, together with their approaches and stations, will cost less than $100,000,000, and where is the money to come from to pay the interest on that investment? The railway companies now landing at Jersey City could not get one penny more from their commuters, or from the travelers coming from a distance, to carry them into New York city over the bridge than they do now for transporting them by ferry. That rate is already fixed by the New York Central & Hudson River R. R. Co., which now alone has its terminus in the heart of the Borough of Manhattan, and yet we can scarcely believe in these progressive and aggressive times, when corporations with a capital of $1,000,000,000 are formed, that the metropolis of this continent will always be satisfied to depend upon the direct service of only one railway company, although that railway is one of the most important lines in the country.

But without the assistance of the various cities and towns on the Jersey side of the river, and without the active co-operation of the city of New York by direct contribution, or by municipal grants, it will be almost impossible to execute and to operate successfully so stupendous an improvement, and especially so from a legal point of view. If New York city would cast aside its fear that a bridge across the Hudson River would drive half of its population into New Jersey, or at least retard its own growth northward, for which purpose the city is now spending so much money; yes, if New York would grow to the full height of its destiny and look upon the cities opposite the river in New Jersey as she does upon Brooklyn, as being after all a part of herself, perhaps then we might all live long enough to point with pride to a structure, magnificent in its lines and proportion, spanning one of the grandest rivers of the world and unsurpassed in history as a work of engineering skill and of civic enterprise. We can all contribute, by impartial discussion, to the solution of this great problem.

DISCUSSION.

MR. T. C. CLARKE.—I will make my remarks very brief, and confine what I have to say to one feature only of this exceedingly vast subject. The thing on which I wish to speak is the restrictions which the United States engineers have put upon this project, the bridging of the Hudson River. Now, I have the greatest possible respect for that body of men collectively, and a very strong personal friendship for all of them that I have ever met. They are a fine set of men. I cannot be too loud in my praise of them. And yet I must differ with them. In the first place, they have decided that the height of the central part of this bridge must be not less than 157 ft. above high water. Now, my imagination is not capable of conceiving why in the world they did that, except for one reason. There is one reason—that one of these days we shall exhaust our coal and we shall have to give up steamboats and go back to sailing vessels, and then it is desirable that the bridge shall be high enough for masted vessels to go under. At present I cannot see why masted vessels will want to go under that bridge if it is located far uptown—vessels so tall as not to be able to go under the Brooklyn Bridge. Any vessels of war or other steamships could perfectly well get under a bridge that was 100 ft. above the water, and this addition of 57 ft. means a great deal where space is so limited, and especially if it is to be used for locomotives; 57 ft. means a mile of added length to the bridge approach, and this, in the city of New York, is a very serious business and adds to the cost of the bridge at once.

The other restriction is that of not allowing any piers to be put in the river between the bulkhead lines. If bridges are built at all probably they will be built in the upper part of the island, and it seems to me that if you consider that the most unmanageable craft and the largest that navigate the Hudson River are these great tows of canal boats that come up and down between New York and Troy; they are half a mile long sometimes, and over 400 ft. wide. As a matter of fact, those tows have been navigating the Hudson River for the past 14 years, ever since the Poughkeepsie Bridge has been built, running through 500 ft. clear span, at all hours, night and day, in all weathers, and there never has been any serious accident yet. Why we should make those spans so wide here I cannot see. If those restrictions could be modified so as to reduce the span required to 2,000 ft., with two piers in the river, then instead of talking about $100,000,000, the figures come down very much.

I am not prepared, and I do not suppose anybody else is, to say very much, but we can say this, that there is a certain great tax on all commerce for all time—I mean land transportation—which will continue forever, if any restrictions are put on this bridge which are unnecessary; and I think the first thing that the projectors of this bridge ought to do is to endeavor to appeal to public opinion and state the facts in such a way that Congress and the United States engineers will modify those restrictions and allow the bridge to be built more in accordance with the railway bridges that span the other great rivers of the United States.

MR. H. G. PROUT.—I have never been able to see how the investment necessary to build a bridge across the North River could pay interest. Let us consider first the through passenger traffic. That is one of the reasons for a North River bridge which appeals first to the owners of the railroads reaching the west side of the river. They have seen the New York Central R. R. gradually encroaching upon that traffic, taking year by year a greater percentage of the through traffic out of the city of New York, the Pennsylvania gradually falling behind. By improving their terminals on this side of the river and by putting on double-decked ferryboats and faster ferryboats and so transferring their passengers with greater expedition and comfort those roads would, I imagine, get back a considerable part of that through passenger traffic which they have lost. But supposing they got back all of that through traffic, what would that amount to in the way of paying interest on $100,000,000? Nothing; it would be a fraction of 1%. You might just as well leave it out of consideration entirely. When you come to consider the maintenance expenses and operating expenses and interest on a bridge of that sort, the through passenger traffic cuts no figure whatever.

Let us consider the suburban traffic, which is perhaps 90%, perhaps 95%, of all the passenger traffic which reaches the west side of the river. How would a North River bridge serve that traffic? Practically not at all. As Mr. Buchholz said to us, 75% of the traffic goes below Chambers St. I venture to guess that 90% of the traffic goes below 14th St. What are you going to do if you bring your passengers across the river and dump them down at 49th or 23d St.? You are are going to deposit them there when every means of getting them downtown is overloaded already and further congest the existing means of transit. Suppose you had the means of taking them down, as Mr. Buchholz suggests, who is to pay for it? Suppose a commuter is paying now $60 a year; is he going to pay in addition $30 a year in order that he may go around by a bridge and be deposited at 49th St. and then get on some city transportation line and go down to his office in Wall St. or on the lower end of the island? Not if there is a ferryboat—surely not. He will take the ferryboat to come across and walk to his office as he does to-day. In other words, the Almighty has provided a most beautiful means of distributing the passengers arriving at the west side of the river. There is the great river. All you need to do is to put on your boats and distribute the traffic up and down the shores of the island. And that is what you should aim at. As a transportation problem you should aim at the distribution of that traffic just as soon as you possibly can, not throttling it down and wire-drawing it across a bridge and depositing it at one place and then distributing it. That is illogical. That is not transportation science at all.

The same argument applies to the freight business, as Mr. Buchholz has pointed out. It is highly probable that the freight coming to the west shore of the river will always be distributed more cheaply and more expeditiously by the floats and the water communication than it could possibly be done by a bridge.

MR. G. LINDENTHAL.—Referring to the point made by Mr. Clarke about the stipulation of the United States Government as to the height of a bridge across the North River, I agree with him only in so far that it should not have been greater than is required over the East River, where it is 135 ft. at the centre of the span above high water. As regards the feature of the single span over the entire river, I think there is no fault to be found with that prescription of the Government. I pointed out the entire feasibility of a single-span bridge of 3,100 ft. more than 14 years ago, at a time when the great majority of bridge engineers believed such a span impracticable. The North River bridge, when built, will not cross a river but a harbor, than which none busier exists in the world. The steamships are getting longer year by year, and it requires sometimes half a dozen tugs, taking nearly the whole width of the river, in maneuvering the ships in and out of their slips. A pier in the river would be a very serious detriment to the navigation interests.

That is not the only point. One or more piers in the river would not cheapen the bridge much, if any, because of the excessively deep and expensive foundations that would be required for them, over 300 ft. deep down to rock. Moreover, the bridge itself is not the most expensive part of the bridge problem. It is only about one-quarter of the entire cost of the undertaking. The great cost, the overwhelming cost, the cost that cannot be accurately calculated, and which, therefore, is the one that causes the most anxiety, is the cost of right of way and the terminals in this city. Property is becoming more expensive year by year. We may afford and provide for passenger terminals, but to provide room enough for freight terminals is out of the question absolutely, for the reasons that I published many years ago and which Mr. Buchholz has stated so well. I never yet found a railway man who supported the proposition of bringing the freight cars over into New York city by way of a bridge or tunnel which would bring them all to one point and from which they would have to be distributed by trucking. It would make the freight distribution much more expensive than it is now. Mr. Buchholz was right in putting the cost of the bridge crossing at about $100,000,000 for passenger business alone.

It would lead to a much more extended discussion than I am willing to go into at this time—and in fact I came here merely to listen; I did not expect to say anything—to show that the undertaking will pay good interest nevertheless. Let me merely point out the experience with the Brooklyn Bridge. It was built with city money, where the question of how to raise the needed capital for construction did not figure. In 1883, when the bridge was opened, the ferry passengers amounted to about 43,000,000 on all the East River ferries. The bridge alone is carrying now over 100,000,000 paying passengers and about 10,000,000 pedestrian passengers additional who do not pay toll. And the ferries carry besides now over 100,000,000 passengers. No one can deny that the bridge was the direct cause of this increase of traffic to a total of 210,000,000, or about 500%, in about 17 years. Brooklyn has more than doubled its population, but no one can maintain that it would have grown just as fast without a bridge. The Brooklyn Bridge, as everybody knows, has been too small for a long while. Three other bridges over the East River will be completed within the next ten years. In all the four bridges over the East River when completed will represent a cost of about $60,000,000 to the city, paid for by taxation.

The $100,000,000 for a single North River bridge crossing must, on the other hand, be raised by private capital. To raise that amount of money is really the greatest engineering feat in connection with this undertaking. When you come into the financial market for $100,000,000 cash, on which for six years not a dollar can be earned, then you present a most difficult problem. The Brooklyn bridges, as I said, are being built with public money, because they span a stream or estuary entirely located within the State, between Long Island and New York. The East River bridges are city property, but the North River forms the boundary line between two States. The Constitution and laws of both States are in the way of building a North River bridge with public money. It reaches into two States; neither one or both can own the bridge or aid its construction without public credit. You might ask the United States Government to furnish the money, but we can easily imagine how such a proposition would be received in Congress. There is but one way: the money must be raised by private capital. Furthermore, the bridge must be provided with large passenger terminals for the railways, from which at first the largest revenue is expected. If the building of a bridge alone were in question, a great deal less capital than $100,000,000 would be required, as I mentioned before. Mr. Buchholz stated the problem correctly. You may see that it is one that is not easily solved. Spectacular performances and assertions in the newspapers, that all the money is ready to build the bridge and all other things in connection with it, emanate from entirely irresponsible sources. It is a problem for the biggest financiers that the world has, and the difficulty will not be easier in ten years than it is to-day. The cost is increasing steadily by reason of the increase in the cost of property in New York. If the undertaking should fail, it would be simply because the financial engineers could not accomplish as much as the mechanical and civil engineers stand ready to do.

PROF. WILLIAM H. BURR.—The problem is one whose profitable discussion needs a basis of statistics as much as any transportation problem ever did; but so far as I am familiar with it, I believe few have ever been more markedly lacking in that respect. If either Mr. Buchholz or Mr. Lindenthal has such statistics he has not given them to us to-night.

There are some features of the problem which bear upon the construction of the bridge only that were discussed some five or six years ago by a board of engineers appointed by the then Secretary of War which, perhaps, are familiar to most of the members present. I will only add a few words to what Mr. Lindenthal has said in reference to the single-span feature. The main object of the investigation with which the board at that time was charged was the feasibility or possibility of constructing a single span across the Hudson River, or whether a span of 2,000 ft. should be used. The precise location was not prescribed in the instructions of the Secretary of War to that board. It was understood at the time, however, to apply to the project which has been known since as the New York & New Jersey Bridge Co. The location considered lay between about 72d St. and 59th St. In this case a sufficient number of borings were made over that stretch of the river to ascertain the approximate depth at least to which a pier in the river would have to be sunk. It was the conclusion of that board, as is well known, that it was perfectly feasible to build a span of about 3,100 ft. in length, and I am inclined to think that that limitation, if it can be called a limitation, to a bridge project, does not add materially to the cost. The depth to which the foundation in question would have to be sunk is, I presume, not greater than could be reached in some manner if it were imperative to make such a construction. In fact, I think any one would be rash to say that such a foundation could not be constructed. I believe that it could be constructed in some way, although I am not prepared at present to state in just what way. The depth involved, probably say 260 ft., is certainly much greater than any yet reached, and the expense connected with it would be very great. I think it is a safe conclusion that the cost of the bridge would not be materially increased by the lengthened span necessitated in this case by the omission of such a pier.

The features of the bridge which bear upon the revenue or the possible return for the amount of money invested, that portion of the question is one which is still open to quantitative treatment. I believe it yet to be doubtful, but I will not be more positive in the statement than that, whether it would be feasible to induce a great amount of freight traffic to pass across such a structure. It might be, but it is not now clear in what way it would be done. It is somewhat hazardous, as it would be in connection with the construction of the very deep foundation involved in the pier in the middle of the river, to state that such and such results cannot be accomplished; but I am inclined to think that this bridge, if constructed, would not be a great carrier of freight. It would, undoubtedly, be a great carrier of passengers if there were provided for the New York approaches suitable arrangements by which change of trains for downtown destinations might be avoided. Furthermore, a source of revenue to some extent, perhaps only to a small extent, might be opened for the bridge as a carrier of electric cables for the transmission of power from central power stations placed at points in the surrounding country where it can be generated with much more economy than on Manhattan Island. This is not an imaginary source of revenue, for it has already appeared under conditions similar to those under consideration, and its development is at least worthy of attention.

MR. WALTER G. BERG.—I would repeat the opinions I expressed some years ago at a meeting of this club, that the ferry service both for passenger and freight transportation across the river is the best and most elastic, accommodating itself to the changing conditions, and therefore far superior to any bridge or tunnel scheme where traffic would have to be concentrated at one point, and its distribution take place from the New York end of such a line.

MR. O. F. NICHOLS.—It would seem that the problem of an all-rail connection across the Hudson could well be separated into two problems; one for the handling of freight and one for the handling of passengers, and that the constructions for each should be kept far apart. It should be conceded that it is impossible to hold any large number of cars in the city; if cars must be stored, this should be done in the suburbs, and economy as well of time as of labor dictates that loop systems should be used to the fullest practicable extent with adequate facilities for loading and unloading. The freight of the future should be brought into the city through tunnels under the river or bay, and should, preferably, enter through one tunnel and leave through another, with connecting tunnels traversing both sides of the lower sections of the city, and with perhaps half a dozen underground freight stations at points convenient for collection and distribution. A serious objection to the present Rapid Transit Railway is that it, to an extent, occupies territory which could be better used for this work, without giving better passenger service than could be secured in other ways.

The great bulk of the passenger service over the Hudson can probably be better handled on a single great bridge than in any other way. A bridge of this character, built to land between 14th and 28th Sts., and provided with a great loop-house for a terminal station west of Broadway, would provide for the handling of most, if not all, of the passengers entering the city by the railways from the West. There is a disadvantage in such a concentration, or, rather, there is a great advantage in having numerous stations scattered widely over the city, as in London; but the cost of bridges over the Hudson is so great that we cannot expect to build more than one in a century, and must develop the capacity of this one to its fullest extent.

In time the boroughs of the city located on Long Island will contain the greater portion of the population of the city, and tunnels similar to the one proposed by Mr. L. L. Buck some years ago may, at some day, be built, and used for passengers as well as freight to that section of the city. For the near future, however, a single great bridge over the Hudson, as outlined above, would serve a most valuable purpose in the interests of passenger traffic. It will, however, be a mistake to use it extensively for freight, which requires quite different terminals and terminal locations, and which, in my judgment, can be much better served by tunnels with underground as well as surface stations at several points in the lower portion of Manhattan Island.

MR. J. V. DAVIES.—I am aware that there is a general feeling on the part of engineers (which I know to be shared by Mr. Buchholz) that the materials on the bed of the Hudson River are not adapted for the safe construction of tunnels under that river. A part of this feeling has had good cause in the checkered history and difficulties of the old Hudson River Tunnel, and it is from the object lesson of the present condition of that work that I would draw my conclusions.

The material on the bed of the Hudson River is a stiff clay silt, produced by the scour and erosion of the ancient rocks of the entire Hudson and Mohawk Valleys. Below this silt formation is a more or less hard and compact sand. The present deep channel of the Hudson River is on the New York side of the center of the river, whereas the ancient deep channel of the Hudson Valley in its glacial era was unquestionably aloong the line of the Palisades, and consequently very near to the ends of the piers of what is now Jersey City. In this ancient channel there is no rock bottom to be found for over 200 ft., and very probably in many parts for over 300 ft. depth below water level, whereas under the shore both of Jersey City and of New York city the rock comes up to within 60 ft. of the surface.

At the time of commencement of reorganization proceedings in connection with the Hudson Tunnel Co., about 18 months or two years ago, we pumped out the old works and bored a number of holes through the iron lining of the present portion of the tunnel in order to ascertain the condition of material in the rear. The consistency of this material is about equal to a stiff brick clay. It is very easy material to tunnel in with a shield, and the completed tunnel will be very nearly perfectly water-tight. There have been so many statements made with regard to the flotation of the tunnel that we have carefully checked both alinement and profile of the already completed tunnel as it exists to-day. There is no indication that any change has occurred in the position of this old tunnel, and I do not believe that any is likely to occur. On the other hand, I am aware that there is a feeling on the part of other engineers that the impact and vibration of railroad trains would after a time pound the tunnel down lower into the clay. This is a possibility, but not by any means a likelihood. At the same time I would by no means advocate the construction of any tunnel under the Hudson River for purpose of steam traction with an ordinary locomotive engine. I do not consider that a tunnel under that river and for the great length which it would require to be constructed and for passenger service in this city, is in any respect adapted for that class of transportation. If, therefore, it is necessary to the railway interests terminating at Jersey City that the trains consisting of Pullman cars or equally large passenger coaches, with their main line engines, should be transported without breaking load direct into the city of New York, then I would most certainly not advocate the construction of tunnels for that purpose, and consider that a bridge would be the only means for effecting that transportation if the bridge engineer can show that it is feasible at the present day to construct a railway bridge over the great span necessitated by the width of the Hudson River.

On the other hand, however, for local service between the suburbs in New Jersey and the Borough of Manhattan by use of electric traction, either by motor cars in units or in trains, or even with moderate length of trains operated by electric locomotives so that the concentration of weight in the locomotive is not extremely excessive, then I consider that the eminently feasible and economical plan to adopt is the construction of tunnel. These tunnels can be multiplied to any number, dependent only upon the necessary number of railway tracks which are required and limited by the population to be moved per day.

The past history and experience in the Hudson River Tunnel and in the East River Gas Tunnel makes it evident that a modification is needed in the design of the lining and in the arrangement of track construction and the sizes of the tunnels as well as in the depth and grades of the tunnel itself. With these provisions, however, I feel perfectly confident that thoroughly efficient and permanent tunnels can be constructed under the Hudson River for transportation use, and they will unquestionably be cheaper in first cost than any bridge which, with our present knowledge, it is possible to construct over the waters of that river.

PARKING WIDE CITY STREETS.

By Robert L. Johnson.*

The City of Columbus, Georgia, is situated on the east bank of the Chattahoochee River, at the head of navigation, a distance of 360 miles by river from the Gulf of Mexico. It is located upon an almost level plateau, or bluff, extending along the river at this point, and the original limits included an area about one mile wide and two miles long.

FIG. 1. VIEW OF SECOND AVE., COLUMBUS, GA., SHOWING PARKED STREET 132 FT. WIDE, WITH 30-FT. CENTER DRIVEWAY.
(West side of street 5 ft. lower than east side.)

The town was established in December, 1827, by an act of the Georgia Legislature, entitled, "An act to lay out a trading town, and to dispose of all the lands reserved for the use of the state near Coweta Falls, on the Chattahoochee

*Superintendent Department Public Works, Columbus, Ga.

River, and to name the same." It was laid out in the early part of 1828 into streets and rectangular blocks, the streets running due north and south and east and west. The longer streets are those running north and south; they run practically parallel with the river, and are 132 ft. wide; these running east and west are 99 ft. wide. The blocks were intended to be 591.33 ft. long and 295.66 ft. wide.

FIG. 2. VIEW OF FOURTEENTH ST., COLUMBUS, GA., SHOWING PARK SPACES EACH SIDE OF 50-FT. DRIVEWAY.
(Grade of street has been lowered 3 ft.)

It will thus be seen that the original object in creating the City of Columbus was to establish a "trading town" in this section of the state. But the valuable and abundant water power afforded by the Chattahoochee River, as it passed over the "Coweta Falls" was soon recognized, and early in the history of the city manufacturing industries were instituted, which obtained their power from the river.

Columbus has accomplished the purpose for which it was originally established, as it has always done, and still does a large amount of commercial business; but it has also gained the distinction of being the largest manufacturing city in the South. The river in passing over the Coweta Falls, which is nothing more than a series of shoals, falls about 114 ft. in four miles, and there is created within this distance about 67,000 available gross horse-power, 20,000 of which is within the city limits.

There are, at the present time, two large cotton mills, one flouring mill and one electric power plant, furnishing commercial power, also operating the street railway and lighting systems located in the city, and utilizing some of this water power. Just above these plants, a distance less than one mile, an electric power plant for long distance transmission has just been completed which develops 8,000 HP.; also two large cotton mills, which take their power from this plant.

With the exception of the planting of shade trees, which was done by the citizens at large, and without any systematic plan or direction, no efforts appear to have been made by the early city authorities and inhabitants to improve or beautify the streets. No grades were ever established or even laid out, and when a piece of property was improved or built upon, each man located his front or floor line as best suited his taste or convenience.

It was only about seven years ago that the problem of paving the streets was undertaken. The first efforts in this direction consisted in building on one of the business streets, which was 164 ft. wide, strips of macadam and telford pavement from 30 to 35 ft. wide on each side, leaving the center unimproved. This pavement was laid without any substantial curbing along the sidewalks, and for the most part without much regard to systematic and uniform grades. In 1896 the first standard stone curbing was placed on some of the sidewalks, and from then on the sentiment and desire for substantial street improvement has grown stronger each year.

On account of the great width of the streets it was realized at the beginning of the movement for street improvement, that some plan would have to be devised by which the quantity of street pavement could be reduced to the smallest amount possible to accommodate the traffic, and at the same time beautify and improve the street. Other cities had constructed parks in the center of their broad streets with driveways on each side, and this plan was adopted for some of the 132-ft. streets. The parks are made from 30 to 36 ft. wide, driveways from 28 to 32 ft. wide, and [illegible] walks from 17 to 20 ft. wide. There is a double row of shade trees in the parks, and one row on each sidewalk.

On some of the 132-ft. streets there is now being carried out a plan of improvement somewhat novel in its conception and method. The plan consists in making a driveway 30 ft. wide in the center of the street, and converting the space on each side of this driveway into a lawn or park, which makes the distance from curb line to property line 51 ft.

On the 99-ft. streets the curb lines are extended making driveways 30, 40, 50 and 60 ft. wide as necessity may require, and the space between the new curb line and the traveled walkway is converted into a lawn, just as is done on the 132-ft. streets. On the lawns and center parks, and the outer edges of the sidewalks, Bermuda grass is grown, which makes a beautiful effect. It is easily grown and kept in order, as it is a very hardy grass, stands mowing closely, and makes a perfect sod.

The center driveway with side parks produces a very pleasing effect, and is much admired and liked by the citizens residing on the streets which have been thus improved. It solves the problem of bringing the amount of street pavement within reasonable and practical limits, it beautifies the street and property, and has the desirable feature of removing the dust of the roadway farther from the houses.

Another very desirable feature of this plan of improvement is the great advantage it affords of adjusting the grades of the roadways and curb lines. Every engineer who has had to fix grades on old and unimproved streets, where the abutting property is built up and improved, with trees growing on the sidewalks, many of which are also paved ,and all of which work was done without any regard to uniform or systematic grade lines knows what it is to fix the grades on such streets so that they will appear at all decent, and escape the unmerciful criticism and wholesale abuse of the abutting property owners.

In the accompanying views, Fig. 1 shows a 132-ft. street, with 30-ft. center driveway, where one sidewalk is about 5 ft. higher than the other. At this place the grade of the old roadway was lowered about 2 ft. 6 ins., and the lawns on each side sloped back to the old sidewalk grades, which were not altered.

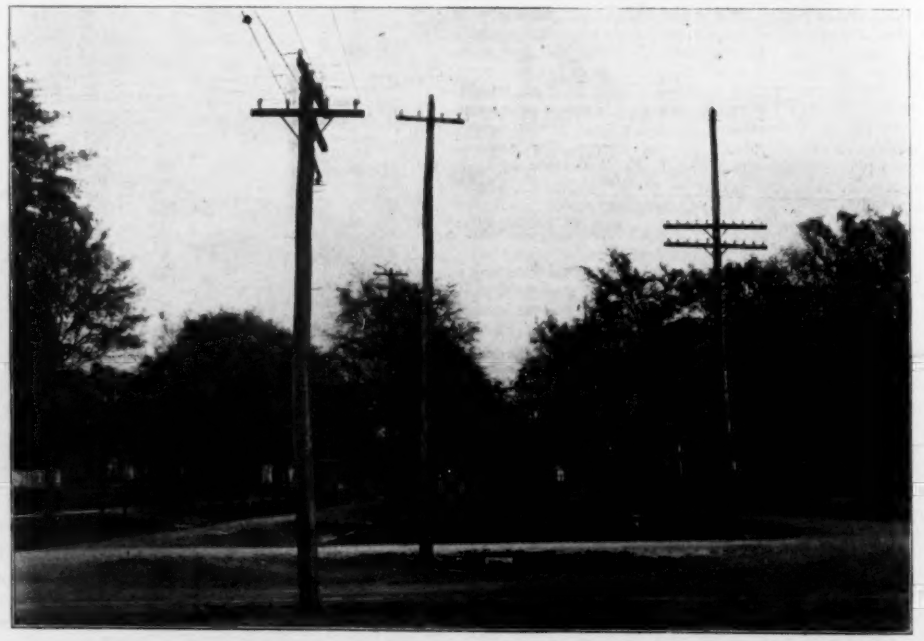


FIG. 3. VIEW OF THIRD AVE., COLUMBUS, GA.; STREET 132 FT., WITH 30-FT. CENTRAL PARK AND TWO 30-FT. DRIVEWAYS.

Fig. 2 shows a 99-ft. street with 50-ft. driveway, where the old grade of the driveway was lowered 3 ft. Fig. 3 is a view of a 132-ft. street with park in the center 35 ft. wide, and a 30-ft. driveway on each side.

THE PORTLAND CEMENT INDUSTRY IN NEW YORK.*

By Edwin C. Eckel, Assoc. Am. Soc. C. E.†

INTRODUCTION.

The paper here presented is the second of a series of three discussing the Portland cement industry in New York. The first and third, dealing respectively with the early history of the industry in this state and with the tests made by the State Engineer during the years 1897, 1898, 1899 and 1900, will appear as appendices to a Museum bulletin, to be issued in the near future.

It was at first my intention to publish the first of the series as an introduction to the present discussion, but the detailed information generously placed at my disposal by Messrs. Coykendall, Duryee and Sanderson was of such interest as to demand separate treatment. I have, therefore, summarized the early history of New York Portlands in a single paragraph, and must refer those interested to the Museum bulletin above noted for a more complete description of the pioneer work carried on by these gentlemen and their associates.

My thanks are due to Dr. F. J. H. Merrill, Director of the New York State Museum, for his kind permission to publish the results of my work for the museum. Without exception, the heads of the various cement plants in the state have aided me in the preparation of this paper. In some cases certain information furnished by them has been of so detailed and confidential a character as to render publication inadvisable, and I have therefore only used it in preparing the brief and generalized technological discussion which closes this paper.

I am indebted to Mr. A. L. Parsons, of the New York State Museum, for data on the clay deposits at Mt. Morris, and also for certain parts of the description of the plant and processes of the Empire Portland Cement Co.

EARLY HISTORY.

In Engineering News for May 31 and July 26, 1900, will be found communications of much interest from Messrs. Sanderson and Duryee, bearing on the early history of Portland cement manufacture in New York. So far as I know, these are the only presentations in print of the facts relative to the pioneer work on this industry in this state. For that reason a brief abstract of the history of these early experiments may be of interest.

The earliest work in this line was carried on by the National Portland Cement Co., at East Kingston, Ulster county. The cement was made from marl and clay by a wet process, burned in dome kilns, and attained a very high crushing strength, according to Gillmore. Later some cement was made up, at another point on the river, for use in the piers of the first (projected) Poughkeepsie bridge. About the same time Mr. Sanderson began his experiments, first at Croton Landing, later carrying them on at Carthage Landing. In 1882 the Walkill Portland Cement Co. was organized, and works were erected by it at South Rondout. Some years later Duryee's rotary kiln was introduced at these works, proving very successful. Destruction of the plant by fire closed operations here. The next plant in order of date, excluding plants still in existence, was that erected at Montezuma, where the rotary kiln was first used directly on wet raw materials. Highly successful technologically, this plant also was destroyed by fire in 1892, and with it ended the first phase of Portland cement manufacture in New York state. Other works had started as early as 1886, which are still in operation, but an entirely different set of men were in charge, and the later development of the industry here was not independent, but was bound up closely with that of cement manufacture in Pennsylvania, Ohio and Indiana.

PORTLAND CEMENT PLANTS IN NEW YORK STATE.

AMERICAN CEMENT CO.—The plant of this company, located two miles east of Jordan, Onondaga county, was erected in 1892. The works were operated without any interruption until 1900, during which year they were shut down, owing to new construction by the company at Egypt, Pa.

The materials used were marl and clay, both obtained from a marsh near the works, another bed of marl being owned by the company nearer to Jordan Station. The marl is white, and the bed varies in thickness from 8 to 15 ft. It is overlaid by a thin bed of muck, and underlaid by a blue clay. The muck being stripped, the marl and clay were dug, and transported to the works by a wire ropeway. The clay was dried and ground separately, after which it was mixed with the marl in pug mills. The resulting slurry was spread out on a drying floor, and cut into bricks. These bricks were then loaded on platform cars, dried in tunnels heated by coal fires, and fed to the kilns. Twelve kilns, of the dome type, were in use, coke being used as fuel.

The clinker was reduced, first in Gates and Mosser crushers, and finally in Griffin mills. The cement was marketed as the Giant (Jordan) brand. Analyses of the raw materials and finished product, furnished by the company, follow:

	Marl. Per cent.	Clay. Per cent.	Cement. Per cent.
SiO_2	0.14	65.68	21.86
Al_2O_3	0.36	24.08	7.17
Fe_2O_3			3.73
CaO	53.16	2.01	61.14
MgO	1.50	1.75	2.34
SO_3	.....	.....	1.94

CATSKILL CEMENT CO.—The Portland plant of the Catskill Cement Co., located at Smith's Landing, Greene county, was erected during 1899, and shipments were commenced in July, 1900. The materials used are clay, from the river terraces, and limestone of Helderberg age. A bucket cableway is used to transport the raw materials from the quarry and claybank to the works. Average analyses of these materials, furnished by the company, follow:

	Limestone. Per cent.	Clay. Per cent
SiO_2	1.54	61.92
Al_2O_3	0.39	16.58
Fe_2O_3	1.04	7.84
CaO	53.87	2.01
MgO	0.52	1.58
Alkalies	0.00	3.64
SO_3	0.00	trace.

The limestone is dried and then reduced in a Smidth ball-mill. The clay is passed through a roll disintegrator and is dried. The materials are, at this stage, mixed dry; and the mixing and reduction completed in Davidsen tube mills. Two rotary kilns are in operation, having a total capacity of about 300 barrels per day. The clinker is crushed in ball mills, and receives its final reduction in tube mills. The cement is marketed as the "Catskill" brand. Analyses of the finished product follow. All were furnished by the company, 1 and 2 having been made in their laboratory; while 3 was made by H. E. Keifer, Ph. D.

	No. 1.	No. 2.	No. 3.
SiO_2	22.48	21.94	23.44
Al_2O_3	6.52	6.02	6.35
Fe_2O_3	4.46	4.38	3.99
CaO	62.93	64.62	63.21
MgO	1.48	1.25	1.15
SO_3	1.30	1.12	1.22

EMPIRE PORTLAND CEMENT CO.—In 1886 T. Millen & Sons commenced the manufacture of Portland cement at Warners, Onondaga county. In 1890 the plant was purchased by the Empire Portland Cement Co. and the works were almost entirely rebuilt, a much larger output being secured by the improvements then introduced. Since that date the plant has been in constant operation, with the exception of stops aggregating only some five or six weeks in all, caused by fires.

The materials used are marl and clay, obtained from a swamp in the vicinity of Warners, the present workings being located about three-quarters of a mile from the works.

The marl bed covers an area of several hundred acres, of which about 100 acres have already been excavated.

A revolving derrick with clam-shell bucket is employed for excavating the marl, the clay being dug by hand.

The materials are taken to the works over a narrow-gage railway owned by the company, on cars carrying from three to five tons each, drawn by a small locomotive.

At the works the cars are hauled up an inclined track by means of a cable and drum to the mixing floor.

The swamp from which the raw materials are obtained shows sections, from top to bottom, approximately as follows:

Material.	Thickness in feet.
Muck	1 to 2
Upper bed; white marl	4 " 7
Lower bed; gray to brown marl	4 " 7
Sand	0 " 1
Bluish clay	2 " 5

As might be expected from the relative color of the marls, the materials from the lower bed shows, on analysis, more organic matter than that from the upper bed, for which reason more of it must be used, with the same amount of clay, than of marl from the upper bed. This distinction is accompanied by other slight but rather constant differences in chemical composition, which have also to be taken into account in the preparation of the cement mixture.

Analyses of the raw materials follow. Those marked 1 and 3 are quoted by Cummings ("American Cements," page 253), while 2 and 4 were recently furnished us by the company:

	Marl. 1	Marl. 2	Clay. 3	Clay. 4
SiO_2	0.26	0.26	40.48	42.85
Al_2O_3	0.10	0.21	20.95	13.51
Fe_2O_3		0.01		4.49
Ca CO_3	94.39	91.03	25.80	22.66
Mg CO_3	0.38	0.40	0.99	6.92
K_2O	.....	.....	3.14	3.08
SO_3	.....	.....	.....	2.85
Organic	1.54	1.68	8.56	.....
Water + loss	3.10	6.30		

It will be noted that the clay used here runs higher in lime than does any other used in the state, the nearest approach to the above analyses being shown by that of the clay used at Wayland, which carries a little less than 20% of lime carbonate.

The clay is dried in Cummer "Salamander" dryers, three being in use, after which it is carried by conveyors to the mills, being cooled before grinding. These mills are of the Sturtevant "rock emery" type, and reduce the clay to a fine powder, in which condition it is fed to the mixer after weighing. The marl is sent directly to the mixing machine, no preliminary treatment being necessary. The marl and clay are weighed, to secure proper proportions. The relative amounts used will, of course, vary with changes in the chemical composition of the materials, the average charge being about 25% clay and 75% marl.

The mixing is carried on in a mixing pan 12 ft. in diameter, in which are two large rolls, each about 5 ft. in diameter, with 16-in. face, which grind and mix the materials thoroughly. The mixture is sampled and tested, after which it passes, on a belt conveyor, to two pug mills, where the mixing is completed and the slurry is formed into bricks about 3 ft. long and 5 ins. diameter. These bricks are placed on slats, which are loaded onto rack cars, and run into the drying tunnels. These tunnels are heated by waste gases from the kilns, and require 24 to 36 hours to dry the bricks.

After drying, the bricks are fed to the kilns, which are charged with alternate layers of coke and cement mixture. Twenty kilns, all of the dome type, are in use. The coke charge for a kiln is about four to five tons, and 20 to 26 tons of clinker are produced per kiln at each burning. From 36 to 48 hours are required for burning the charge. After cooling the cement clinker is shovelled out, and sent to the reducing department. It receives its first reduction in a Blake crusher. From this it passes to Smidth ball-mills, three of which are in operation. The final grinding is accomplished with Davidsen tube mills, two being in use.

The cement manufactured by this company is marked as the "Empire" and "Flint" brands. The superintendent of the company states that the difference between the two brands lies in the fact that the Empire is made from specially selected clean clinker, while in the case of Flint no selection is made, the whole product of the kiln being allowed to go to the grinding machinery.

Analyses of the Empire brand follow: (1) is quoted by Cummings ("American Cements," pp. 36); (2) by Lewis ("Mineral Industry," VI; pp.

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†Assistant in Geology, N. Y. State Museum, Albany, N. Y.

99); while (3) was furnished directly by the company recently:

	(1)	(2)	(3)
SiO_2	20.80	22.04	21.98
Al_2O_3	7.39	6.45	8.20
Fe_2O_3	2.61	3.41	3.70
CaO	64.00	60.92	61.83
MgO	.....	3.53	1.43
Alkalies	.....	.....	0.84
SO_3	.....	2.73	1.18

GLENS FALLS PORTLAND CEMENT CO.—In 1893 this company commenced the erection of a plant at Glens Falls, Warren county, and their cement was put on the market in 1894, as the Iron Clad brand. Six shaft kilns of the Schoefer type were installed, the Glens Falls plant being therefore the second in this country to make use of this type of kiln. Though highly economical in fuel, the kiln is rather expensive in both the quantity and quality of manual labor required to operate it properly. A fire in August, 1899, destroyed the plant, which was rebuilt to give a nominal capacity of 500 barrels per day, and the manufacture of cement was recommenced in August, 1900.

The materials used are limestone and clay. The former is of Trenton age, and is obtained from the Glens Falls quarries. Considerable care is required in the selection and mixing of the stone from the various layers, in order to obtain a suitable and uniform product. A very clean and uniform clay, found overlying the limestone in this area, is the other ingredient. Analyses* of these materials follow:

	Limestone.	Clay.
SiO_2	3.30	55.27
Al_2O_3	1.30	28.15
Fe_2O_3		
CaO	52.15	5.84
MgO	1.58	2.25
SO_3	0.30	0.12
CO_2	40.98	.....
Organic and water	8.37	.....

The limestone and clay are separately dried, and crushed in Blake crushers and rolls. After being weighed on automatic scales, the materials are mixed dry and reduced to a fine powder in Griffin mills. The powder is then fed into wet mixers, where sufficient water is added to allow its being made up into bricks. These are dried in tunnels, heated by waste heat (from the boiler) driven through the tunnel system by blowers.

After drying, the bricks are burned in Schoefer kilns, using coal as fuel. The clinker is passed first through Smidth ball-mills, and finally reduced in Davidsen tube-mills.

An average analysis of the Iron Clad brand shows:

SiO_2	21.50
Al_2O_3	10.50
Fe_2O_3	
CaO	63.50
MgO	1.80
K_2O and Na_2O	0.40
SO_3	1.50

A sand-cement, sold as the Victor brand, is manufactured at these works, and is discussed briefly later in this paper.

HELDERBERG CEMENT COMPANY.—The plant of this company is located at Howe's Cave, Schoharie county. Quarries in the Waterlime group at this point have been long used for the manufacture of natural cement, while quarries higher up, both geologically and topographically, furnished a very pure limestone which was burned into lime.

In 1898, the Helderberg Cement Co. began to utilize the stone from these latter quarries in the manufacture of Portland cement. Commenced on a small scale, the industry would seem to have promised favorable results, as a much larger plant, belonging to the same company, was erected during 1900 and has recently started operations. The new plant has a nominal capacity of 1,500 barrels per day. The materials used are limestone and clay.

As noted below, the limestone used for Portland cement is obtained from the old lime quarries, and the clay from a deposit in the vicinity. Smidth ball mills and Davidsen tube mills are used for crushing, reducing and mixing the materials. The wet process is employed and twelve rotary kilns are in use. The resulting clinker is ground in ball mills and tube mills, and the product is marketed as the "Helderberg" brand.

The various quarries at Howe's Cave show exposures of the different formations from the Clinton up to the Pentamerus. Dr. Chas. S. Prosser has determined that the entire section shown consists of the following rocks, the datum being taken as the level of the Cobleskill at the suspension footbridge.

0-32 ft. covered with soil.

32-56 ft. green, argillaceous shales (Clinton group).

56-63 ft. dark gray, massive limestones (Niagara group).

63-102 ft. gray argillaceous and magnesian limestones (Waterlime group).

102-133½ ft. dark blue limestone (Tentaculite group).

133½-144½ ft. limestones (transitional Tentaculite-Pentamerus).

144½-168 ft. very massive gray limestone (Pentamerus group).

The green shales of the Clinton have been ground and sold for land plaster, though analysis fails to show that they contain any calcium sulphate. Of the 39 ft. of the Waterlime group shown in the section, the lowest 7 ft. are used for natural cement. Two analyses, of material from the base and top of this 7 ft. band, are quoted by Prosser:

	Base.	Top.
SiO_2	12.89	9.92
Fe_2O_3	11.15	.....
Al_2O_3		
$CaCO_3$	55.17	68.32
$MgCo_3$	19.71	18.90

The limestone used in Portland cement manufacture is obtained from the Pentamerus and Tentaculite beds, exposed in quarries just west of the station, on the northern side of the railroad track, while the Clinton and waterlime beds above noted are shown only in the lower quarries. Partial analyses of these upper limestones, quoted by Prosser as having been made by C. A. Schaeffer follow:

	$Si O_2$	$Ca CO_3$
Tentaculite limestone	1.48	95.75
Pentamerus limestone	4.12	93.68

Another sample analyzed by Schaeffer gave:

SiO_2	1.27
Al_2O_3	0.73
Fe_2O_3	
$CaCO_3$	97.24
$MgCO_3$	1.39
SO_3	trace.

As no complete analyses of the materials actually used for Portland were obtainable, I have included this analysis, as the sample, while coming from a quarry not used for Portland cement, is evidently from similar beds, and gives a very good idea of the iron, alumina and magnesia contents of these cement rocks.

MILLEN'S PORTLAND CEMENT WORKS.—After having disposed of their plant at Warners, Onondaga county, to the Empire Portland cement Co., T. Millen & Co. erected their present plant at Wayland, Steuben county, which commenced producing in October, 1892. The works were destroyed by fire in July, 1893, but were rebuilt and began shipping again in October, 1893.

The materials used are marl and clay. The marl is obtained from a swamp near the village of Wayland. Unlike the Onondaga county deposits, however, the marl bed is not underlaid by clay, and the latter material has to be brought from a bank near Mt. Morris, in Livingston county. The clay deposit there worked is one of a series which occur in the terraces bordering Canaseraga Creek and the Genesee River, extending more or less continuously from Dansville nearly to Rochester. The clay for cement is worked at a point about four miles south of Mt. Morris, and is shipped over the D., L. & W. R. R. to the works, a distance of about 20 miles.

The raw materials are mixed wet, without crushing, in pans; passed through pug-mills, made into bricks, and dried in tunnels. The bricks are then burned in dome kilns, 16 of which are in operation. Rolls and Sturtevant rock emery mills are used in the reduction of the clinker. The cement is marketed as Millen's Wayland.

Analyses of the raw materials and of the finished product, furnished by the company, follow:

	Clay.	Marl.	Cement	Clinker.
SiO_2	45.21	0.42	21.08	22.19
Al_2O_3	19.08	1.08	9.56	9.72
Fe_2O_3	6.74			
$CaCO_3$	19.94	93.50	.....	.....
CaO	.....	.....	64.68	63.08
$MgCO_3$	3.27	2.13	.....	.....
MgO	.....	.....	1.85	2.04
$Ca SO_4$	1.55	2.01	.....	.....
SO_3	.....	.....	1.93	1.75
Moisture and organic matter	4.17	0.86	.....	.....
Alkalies and loss	.....	.....	0.90	1.22

The analyses of the clinker were made for the company by Dr. F. E. Engelhardt, of Syracuse, N. Y.

WAYLAND PORTLAND CEMENT CO.—The plant of this company, which is, I believe, owned by the firm which manages the preceding works, is located at Perkinsville, in the town of Wayland, Steuben county. It was erected in 1896 and has operated continuously to date.

The materials used are a light colored marl, from a swamp deposit near the works, and gray clay from Mt. Morris, Livingston county, for their marl deposit, like that of Millen's, is not underlaid by clay. The processes followed are very similar to those employed at the preceding works, especially in the reduction of the clinker. Sixteen dome kilns are in use. The product is marketed as the Genesee (Wayland) brand. Analyses of the raw materials, furnished by the company, follow:

Marl.		Clay.	
Lime	54.40	Silica	59.50
Silica	0.54	Lime	5.15
Fe and Al oxides	0.56	Fe and Al oxides	24.20
MgO	2.34	MgO	2.15
Loss on ignition	42.20	Loss on ignition	14.10

ALLIED PRODUCTS.

SAND CEMENTS.—Two companies, under practically the same management, are at present engaged in the manufacture of sand cement. These are the Standard Silica Cement Co., whose works at Long Island City were described in detail in Engineering News of April 16, 1896, and the Glens Falls Portland Cement Co. At the plant of this latter company, their Iron Clad cement is used, the resulting sand cement being marketed as the Victor brand. At the Long Island City plant the sand was first dried in Cummer dryers; then screened, mixed with the cement in the proper proportions, and ground in Davidsen tube mills. A mixture of one part sand to one part Portland cement gives, in the case of the Victor brand at least, a sand cement whose properties, as shown by the usual cement tests, are closely like those of the original Portland cement used. This is well shown by the tests of the Iron Clad and Victor brands, made by the State Engineer during the past four years, which will be published shortly in a State Museum bulletin. Intimate mixture of the sand and cement, and extreme fineness of grinding, are essentials.

"NATURAL PORTLANDS."—Two firms in New York State manufacture, in addition to their natural cements, brands which are marketed as "Natural Portlands." The limestone is fed, without previous grinding or admixture, direct to the kilns. As the limestone used carries, as shown by analyses of their natural cements, an amount of magnesia (over 8% in the finished product), a present considered inadmissible in a Portland, the value of the resulting cements is problematical. From laboratory tests it would seem that they can usually pass all Portland requirements, though rather low in tensile strength on short-time tests. Concerning the qualities which they develop when used in actual work, I am entirely ignorant; but the cements cannot be worse than some of the poorer foreign Portlands which are unloaded upon the American market. Cements of this type can, of course, be placed upon the market profitably at a price only slightly above that of "natural" cements, the only additional cost being due to a little extra expense in grinding the clinker.

SLAG CEMENTS.—Some time ago the Knickerbocker Cement Co. was organized for the purpose of making slag cement, the intention being to use the slag from the furnaces of the Poughkeepsie Iron Co. Operations are at present suspended, owing to financial difficulties not in any way connected with the cement manufacture itself; and at present no slag cement is made in this State. I have been informed that a plant is in process of erection near New York city, but have been unable to verify this statement. Considering the condition of New York's iron industry, and her great richness in materials for both natural and Portland cement, it seems unlikely that the slag cement industry will ever attain any great proportions in this State.

Within certain limits (which are, unfortunately, not so well defined as might be desirable), slag

*F. H. Lewis, Mineral Industry, VI., pp. 97.

cements are undoubtedly serviceable. Should their properties, good and bad, ever become so well known to justify an engineer in advising or even allowing their use in certain cases, the industry would become of importance in any iron manufacturing district. The only cements which, under such conditions, could compete with them in price, would be the by-product Portlands now made at several points in the United States.

NOTES ON TECHNOLOGY.

The raw materials at present used, in New York State, in the manufacture of Portland cement, are limestones or marls, and clays. Of these, the marls and clays are both Quaternary, in geological age, while the limestones used are from either the Trenton or Helderberg formations of the Silurian. The two plants noted above as manufacturing "natural" Portlands use limestones from the upper portion of the Salina group. One plant, now in course of construction, will use a shale from the upper part of the Hamilton group, in place of the usual clay. The materials fit for use in the manufacture of Portland cement are quite widely distributed, both geographically and geologically, and I hope, in another publication, to discuss this portion of the subject at somewhat greater length than is permissible here.

The number of plants using the different materials are as follows—one plant, inactive during 1900, but not entirely abandoned, being included with those using marl and clay:

Plants using marl and clay	4
" " Trenton limestone and clay	1
" " Helderberg limestone and clay	2

One of the prominent changes which took place during the past year was that in the relative numbers of plants using marl and those using limestone:

	1899.	1900.
Active plants, using marl and clay	4	3
Active plants, using limestone and clay	1	3

Another significant feature is shown by the following table:

	1899.	1900.
Active plants, equipped with dome kilns	4	3
" " " " Schoefer kilns	1	1
" " " " rotary kilns	0	2

An examination of the detailed descriptions of the separate plants, given above, will show that the plants tabulated as using marl and clay are those, and those only, which are equipped with dome kilns.

Of the four plants at which marl and clay are used, the methods at two—Millen's and Genessee Wayland—probably approach more closely to the typical wet process than do those employed at Jordan and Warners. Crushing before burning is not carried to the extent to which it is practiced in the latter plants, solution rather than mechanical reduction being largely depended on, the usual wet-pans and pug-mills being used, with a considerable quantity of water, for both mixing and reducing.

The methods followed at Jordan and Warners are much alike. As the Empire plant was in operation during the past year, while that at Jordan was idle, the former has been described at considerably greater length. It is probable that the practice and the product at Warners represent the highest degree of economy in operation, and quality of product, that can be obtained from marl and clay burned in dome kilns.

In respect to location the Onondaga county plants, both located close to the Erie Canal and the New York Central and the West Shore railways, possess a distinct advantage over the works in Steuben county. This is increased by the fact that the marl beds from which the Steuben county plants obtain their supply are not underlain by clay, which necessitates bringing the latter material by rail from a considerable distance.

The Glens Falls plant is unique, in this State, so far as type of kiln used is concerned. The merits and defects of the Dietzsch, Schoefer and other types of improved non-rotary kilns, have been discussed in considerable detail by various authors. The fact that the Glens Falls product is of such extremely high grade, should not, of itself, be considered as an argument in favor of the Schoefer kiln, as this particular plant has always been exceptionally favored as regards management. The minor technical details are excellent, and it cannot be too strongly emphasized that it is upon the general management and the treatment of the so-called minor details, and not upon the type of kiln used, that the success of a Portland cement plant depends, both as regards profitable working and quality of product.

Within reasonable limits the kinds of raw materials used affect economy and quality as little as does the type of kiln. This statement should, of course, be accepted as subject to certain limitations, as the marls and limestones present two well-marked groups of materials, each of which posesses certain inherent advantages and disadvantages.

The marls are easier to excavate and easier to reduce. They contain, on the other hand, a greater proportion of organic matter and water, per ton of excavated material, than do the limestones. For this reason their transportation and handling, both between bed and mill, and in the mill itself, entail a greater expense per barrel of finished product. A marl deposit is a limited affair, though in the case of a large marsh or old lake bed the limits may be so large as to be safely disregarded. Limestone beds, on the other hand, are practically limitless, the extent to which the bed can be followed being limited only by questions of economical extraction.

As Professor Spencer F. Newberry has pointed out,* an argillaceous limestone used with a comparatively small quantity of a purer limestone, as in the Pennsylvania plants, possesses one decided advantage over a limestone and clay mixture, inasmuch as less thorough mixing and fine grinding is required, for even the coarser particles of the argillaceous limestone will vary so little, in chemical composition, from the proper mixture, as to affect the result but little, should either mixing or grinding be incompletely accomplished. This argument bears against a marl and clay mixture as well as against a limestone and clay mixture, though to a less extent.

At present two plants are producing Portland cement from limestone and clay, burned in rotary kilns. A third plant of the same type—that of the Alsen American Portland Cement Co.—is now almost completed, and will probably commence producing early in the present year; while there is a possibility that a fourth plant will be far enough advanced to be included among the producers for 1901. Of the plants here mentioned two—Alsen's and that of the Catskill Cement Co—possess marked advantages in location. Both are situated in the lower part of the Hudson valley, and near the river. The cost of transportation of so bulky and low-valued an article as cement is such a serious item in the delivered cost per barrel, that the location of a plant with reference to transportation routes, and especially water routes, will influence most markedly its possibilities of success, except in the rare cases where all the product can be disposed of in an active local market.

*20th Annual Report Min. Res. U. S., for 1898. Part II., p. 545.

One plant of a unique type, at least so far as New York is concerned, is at present in course of construction. The feature which will give it distinctive character will be its use of limestone and shale. Considering the materials used, it would seem probable that the powdered mixture will be fed direct to the rotary kilns. This dry process, originating in the Lehigh Valley, can be used successfully in cement works whose mixture consists of hard and dry material, whether the ingredients be two kinds of limestone, or limestone and shale.

The first stage at which the methods in use at all the New York Portland cement plants can be directly compared, is in the reduction practice after burning. Up to this point practice is influenced by the materials used. After burning these considerations have no place.

The most striking feature in our plants, in this respect, would seem to be the extent to which two grinding machines have been introduced within the past few years. These are the ball mill and tube mill. Used together, on clinker, either with or without crushers or other mills for the first reduction, they have proven themselves to be highly satisfactory reducing agents. To a less extent they are also used on raw materials, especially in the plants using limestone. Emery mills are used in a few plants, as are also Griffin rolls.

In general it may be said that the management of Portland plants in this State is decidedly above the average. This statement is made after an examination of the records of those cements which, during the past few years, have failed to meet the requirements of the New York State specifications. On looking over the causes of rejection it appeared that, disregarding entirely defects inherent in the cement, defects chargeable directly to the management occurred less frequently in New York brands than in others. In this group of errors are included, for example, insufficient aeration in the presence of free lime, careless handling of the gypsum, etc. The most striking example of this last error occurred very recently, in a Pennsylvania cement which is usually of very high grade. Of the two per cent. of residue which this particular lot left on a fifty-mesh sieve, rather more than half consisted of large grains of gypsum, averaging probably one-twentieth of an inch in diameter.

THE STILLWATER STONE ARCH OF 1826.

The stone bridge here shown is chiefly interesting as a reminder of early national and state road construction, travel by stage-coach and the transport of freight by Conestoga wagons drawn by stout teams of horses. It is located between Morristown and Hendrysburg, O., on the Ohio division of the old National Road; and, according to the quaint inscription carried, it was built in 1826 by James Lloyd and Robert Wilson, of Hagerstown, Md. The arch spans the Stillwater Creek.

Stone Arch Erected in 1826 on the National Turnpike at Stillwater Creek, near Morristown, O.

Inscription on Stillwater Arch.

The material used in construction was a good quality of sandstone. The arch-span is 40 ft.; width of bridge, 30 ft.; total length, 190 ft., and

the parapet wall is 4 ft. high. Very recently, a township road supervisor—without reverence for antiquity or the good workmanship of other days, tore down one of these parapet walls to provide stone for the construction of a nearby culvert, and substituted a fence for the old wall. We are indebted to Mr. Frederick R. Jones, of Mt. Vernon, O., for the photographs and the historical notes

THE HALL OF FETES AT THE PARIS EXPOSITION.

In the middle of the old Machinery Hall, on the Champ de Mars, the authorities of the late Paris Exposition caused to be erected a structure especially designed for public gatherings connected with the exposition. This structure occupies an area about 377 ft. square, and includes a circular hall having a diameter of 90 m., or 295.2 ft. The lightness and grace of construction of this hall, taken in connection with its effective decoration, make it well worthy of record, and the following general description is taken from a detailed article in "Le Genie Civil" of Nov. 3.

The central circular floor space in this hall is surrounded by galleries, 49.2 and 70.5 ft. wide, respectively, on the faces parallel to and at right angles with the Machinery Hall. Four great vestibules, located on the axes of the hall, form the principal entrances, and the angles outside the circular hall are occupied by rows of seats. The central floor space is covered by a framed dome supported by arches resting upon iron columns; and this dome is lighted by means of a circular window 141 ft. in diameter. Including the great central area, which will hold 12,000 to 13,000 people, this building will accommodate about 20,000 in all.

The method of construction adopted was similar to that used in the other buildings of the Exposition of 1900, and included a light metal framework supporting a metallic lattice frame, which in turn supported the plaster surface. All relief features were modeled in "staff," and the large surfaces were further decorated by paintings by artists of reputation. The great circular hall was covered by a system of 16 framed beams, or arches, including 8 double and 8 single beams, with the main rafters converging at the center. The 8 double beams are placed in couples forming the vestibules of access; and the 8 single beams are spaced uniformly between these. While the double beams spring from very rigid piers, the single beams are simply mounted upon iron columns, with the size of the latter reduced to the lowest limit, so as not to interfere with the view of people occupying the rows of seats behind these single posts. The beams are tied together by a system of panels arranged and framed to support the different decorative features making up the interior of the dome.

The double beams are made up of two single beams spaced 7.38 ft. apart on centers of piers, and connected by lattice-work, the whole forming a rectangular post to which is connected the first member of the main rafter. The single beams frame into a post made up of 8 channel irons with plates between to give it rigidity. The stability of this system of beams is assured by connecting the beams to two framed rings; the first of these is located about 65.6 ft. above the floor, and separates the first and second members of the main rafter; and has an interior diameter of 295.2 ft. This ring is polygonal in form, and is made of two members united by lattice-work, and it forms a horizontal tension member. The second ring is near the top of the dome; it has a diameter of 185.3 ft., is also made of two vertical beams latticed together, and serves to hold the ends of the main rafters. This metal dome is completed by a system of 36 smaller beams, springing from this upper ring and meeting at the center. The upper members of these latter beams are braced together by a system of lattice-work; and the lower members are tied by the metal frames holding the glass.

The base of this dome is supported on a system of latticed arches springing from the main columns, and these arches carry the panels which enclose the dome to a height of about 72 ft. above the floor of the hall. The foundations of the columns are made of concrete capped with masonry and carry cast-iron shoes set in cement. Panels and beams in "armed-cement," on the Hennebique system, support the walls and partitions.

The construction of this hall involved the use of about 1,840 metric tons of metal, divided as follows:

Dome, steel	1,322 tons
Gallery floors, steel	450 "
Gallery supports, cast iron	68 "

The weight of the building, plaster and metal included, was approximately as follows for the different parts of the structure:

Glazed portion of the dome	24.6 lbs. per sq. ft.
Plastered portion of the dome	40.9 " " " "
Circumference of the dome	40.9 " " " "
Lower arches, rotundas and niches	16.4 " " " "

The beams which form the skeleton of the dome are fixed at their bases by bolts firmly anchored to the masonry of the piers, and they are not otherwise tied together at that point. The intermediate ring serves as an abutment for the main rafters and tends to stability. But as it was necessary to give to the columns simple forms with the greatest lightness possible, to meet these conditions and to avoid any tendency to buckling, a second ring was placed at the upper end of the supporting posts.

In erection the greatest care was taken in setting the cast-iron shoes for the columns; and to this same end the foundation bolts passed through cast-iron pipes, permitting some slight play in orienting the shoes. The latter were set at their exact level by means of wooden blocks; and after their position had been verified, all of the free space under them and about the bolts was carefully filled with concrete. The roof of the adjoining Machinery Hall was utilized in lifting the various members into place, and the erection was carried on in two stages, as follows: The piers and

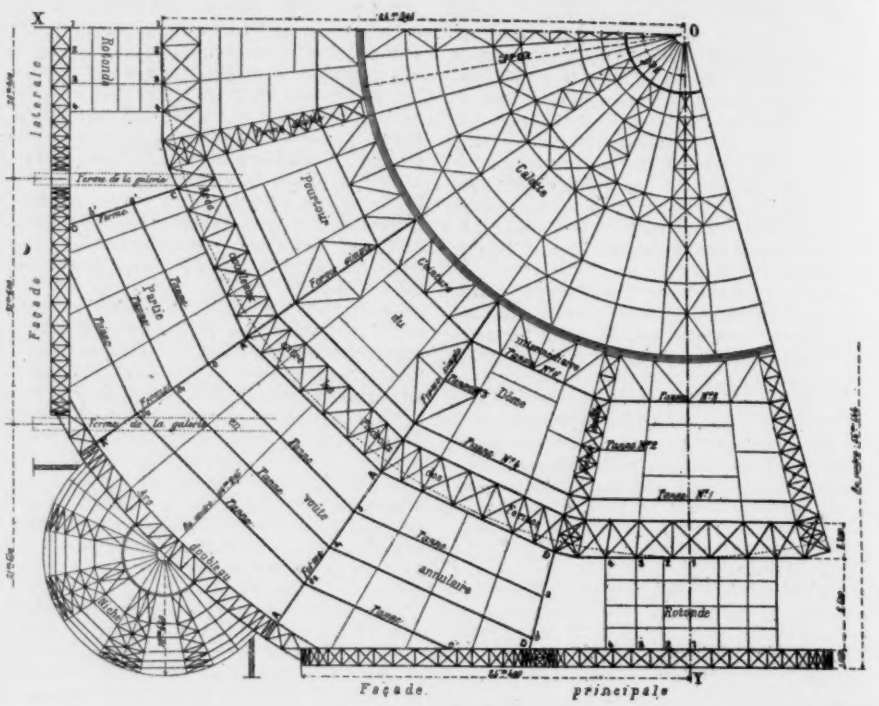

Fig. 1. Quarter Plan.

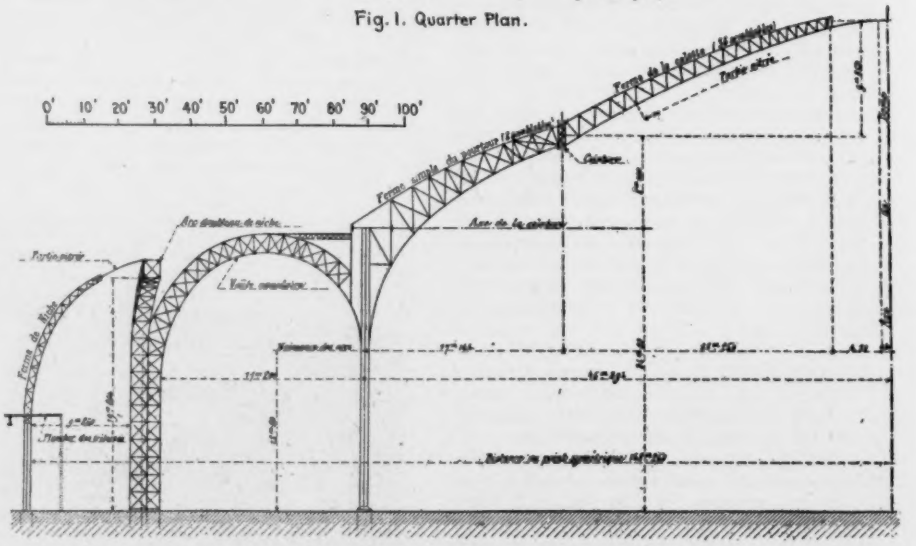

Fig. 2. Section along a Diagonal.

FRAMEWORK OF DOME COVERING THE HALL OF FETES AT THE PARIS EXPOSITION.

The beams which form the skeleton of the dome are fixed at their bases by bolts firmly anchored to the masonry of the piers, and they are not otherwise tied together at that point. The intermediate ring serves as an abutment for the main rafters and tends to stability. But as it was necessary to give to the columns simple forms with the greatest lightness possible, to meet these conditions and to avoid any tendency to buckling, a columns came from the workshop in two pieces, and these were first riveted together and set in their places. Then the lower ring was set up, with its connecting members and the first part of the main rafter. The second stage included the erection of the second and third members of the main rafters, the panels and the second intermediate ring. The placing of the cap of the dome, and the archways and niches at the base of the dome presented no special difficulties.

This work was executed under the charge of M. Resal, Engineer-in-Chief of metallic construction, assisted by M. Duplaix, as Principal Assistant, and M. Rey.